73rd MORSS CD Cover Page

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21-23 June 2005, at US Military Academy, West Point, NY

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Name of Principal Author and all other author(s):

Greg H. Parlier

Principal Author's Organization and address:

Office for Economic Development
University of Alabama in Huntsville
Huntsville, AL 35899

Phone:_(256) 824-2743_____

Fax:_(256) 824-6970_____

Email:_parlieg@email.uah.edu_____

Original title on 712 A/B: Effects-Based Logistics Operations: A Strategic Supply Chain Approach For the US Army

_____

Revised title:_____

Presented in (input and Bold one): (**WG_19**, CG___, Special Session ___, Poster, Demo, or Tutorial):

This presentation is believed to be:
UNCLASSIFIED AND APPROVED FOR PUBLIC RELEASE

Report Documentation Page

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See also ADM201946, Military Operations Research Society Symposium (73rd) Held in West Point, NY on 21-23 June 2005 . , The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
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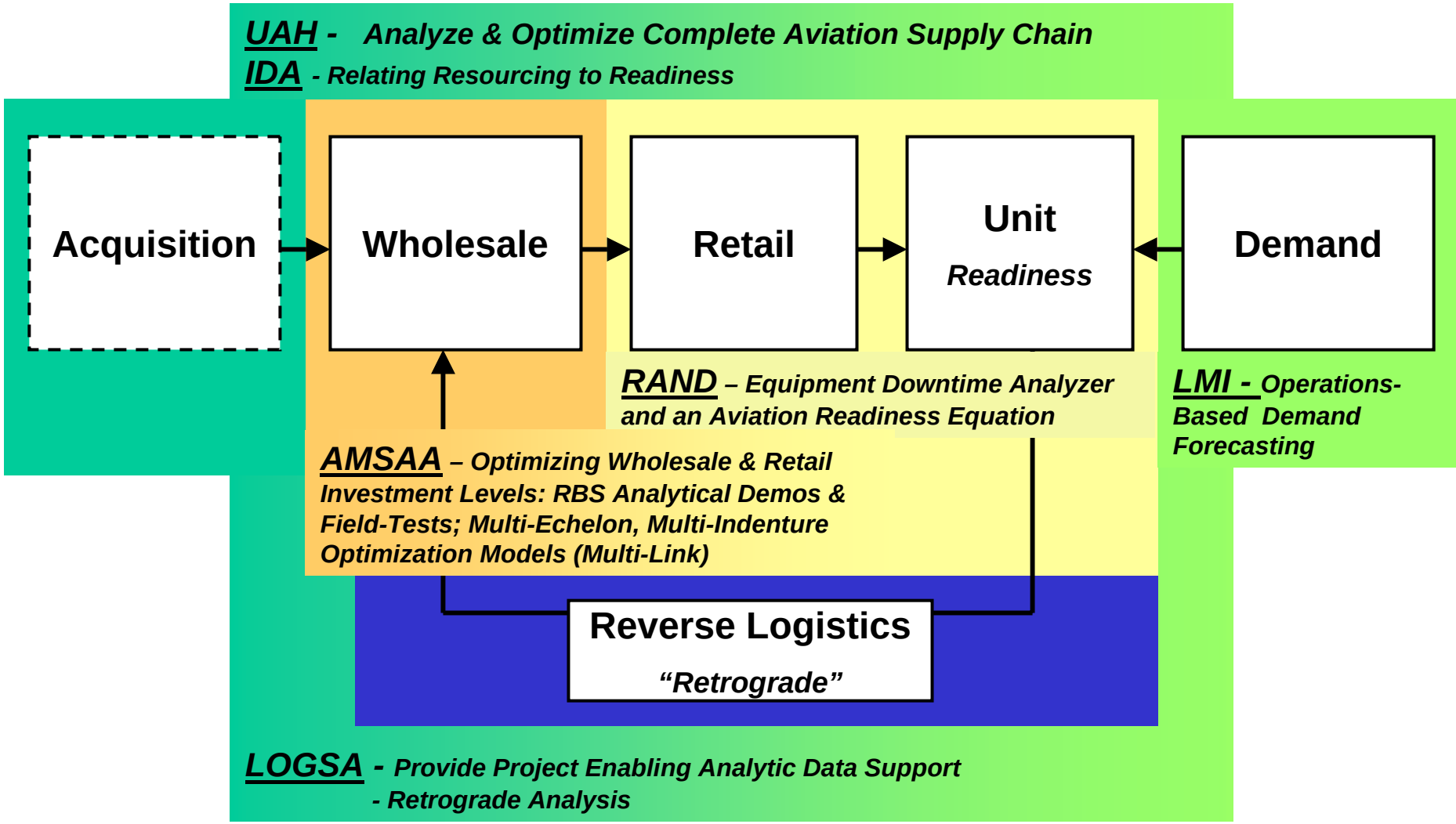
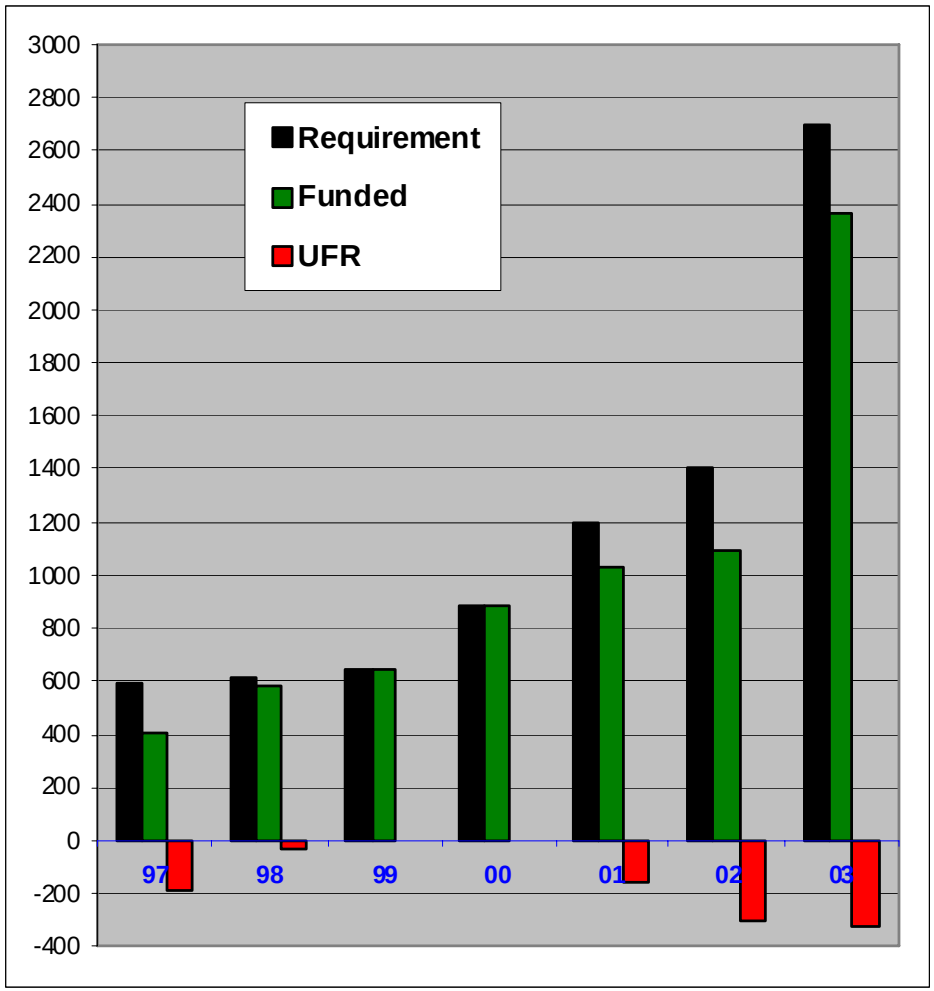
Contents

Initiative Summary

(Readiness Based Analysis / Supply Chain Management)



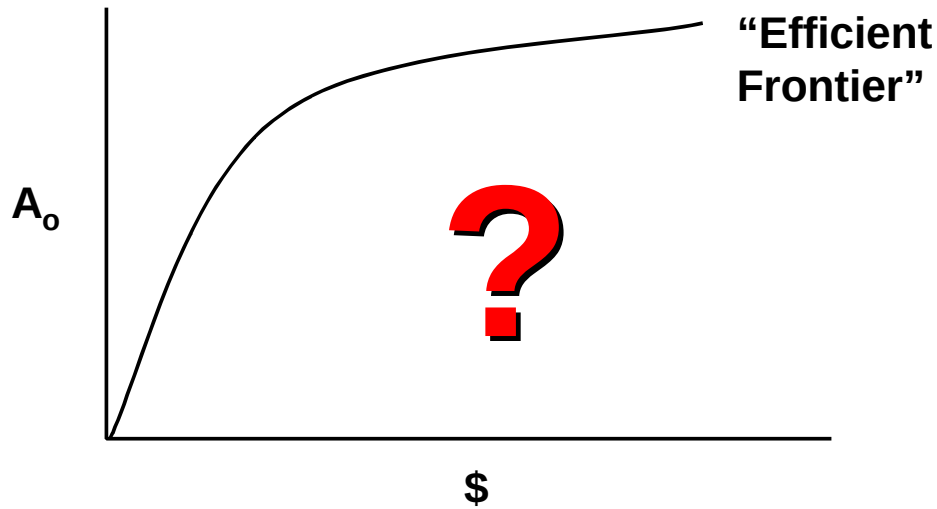
AWCF Hardware (Aviation) Resource Trends

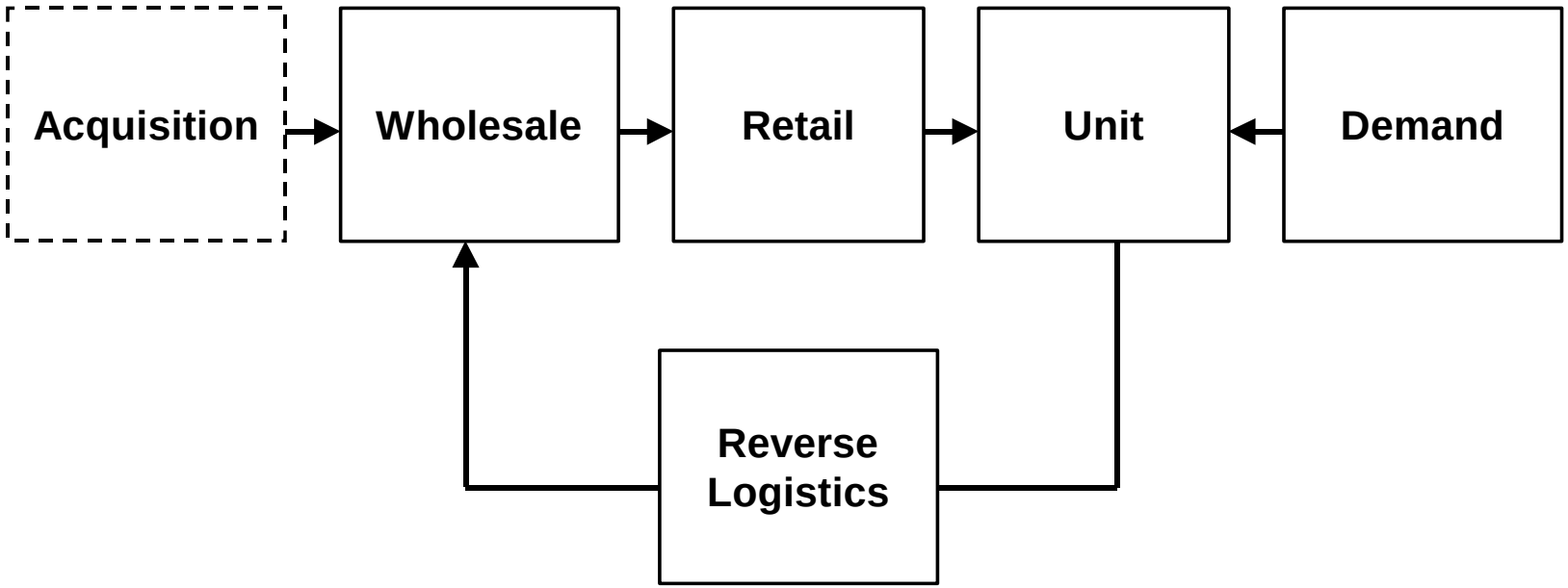


Source: AMCOM RMD

Assessment

- Investment is increasing, yet back orders are growing and UFRs are increasing
- “Workarounds” are increasing, readiness is slowly declining
- Readiness reporting appears suspicious, lacks credibility
- Systems are deadlined for relatively inexpensive parts

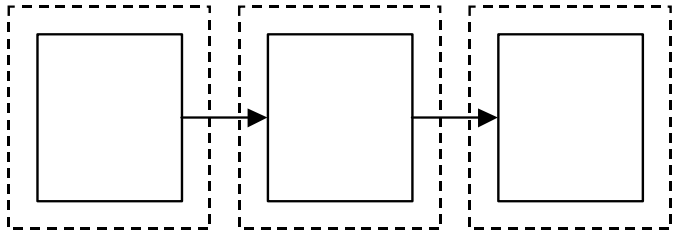



Acquisition
Wholesale
Retail
Unit
Demand
Reverse
Logistics

Improving System Effectiveness: Integration and Optimization

"Segmented" Logistics Support Operations

(Managing the interfaces)

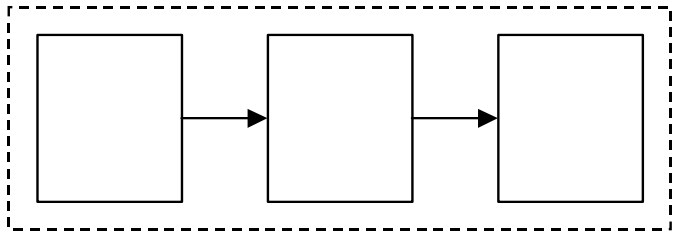


An increase in service level (customer support) requires an increase in inventory and safety stock: increase "Safety Levels"

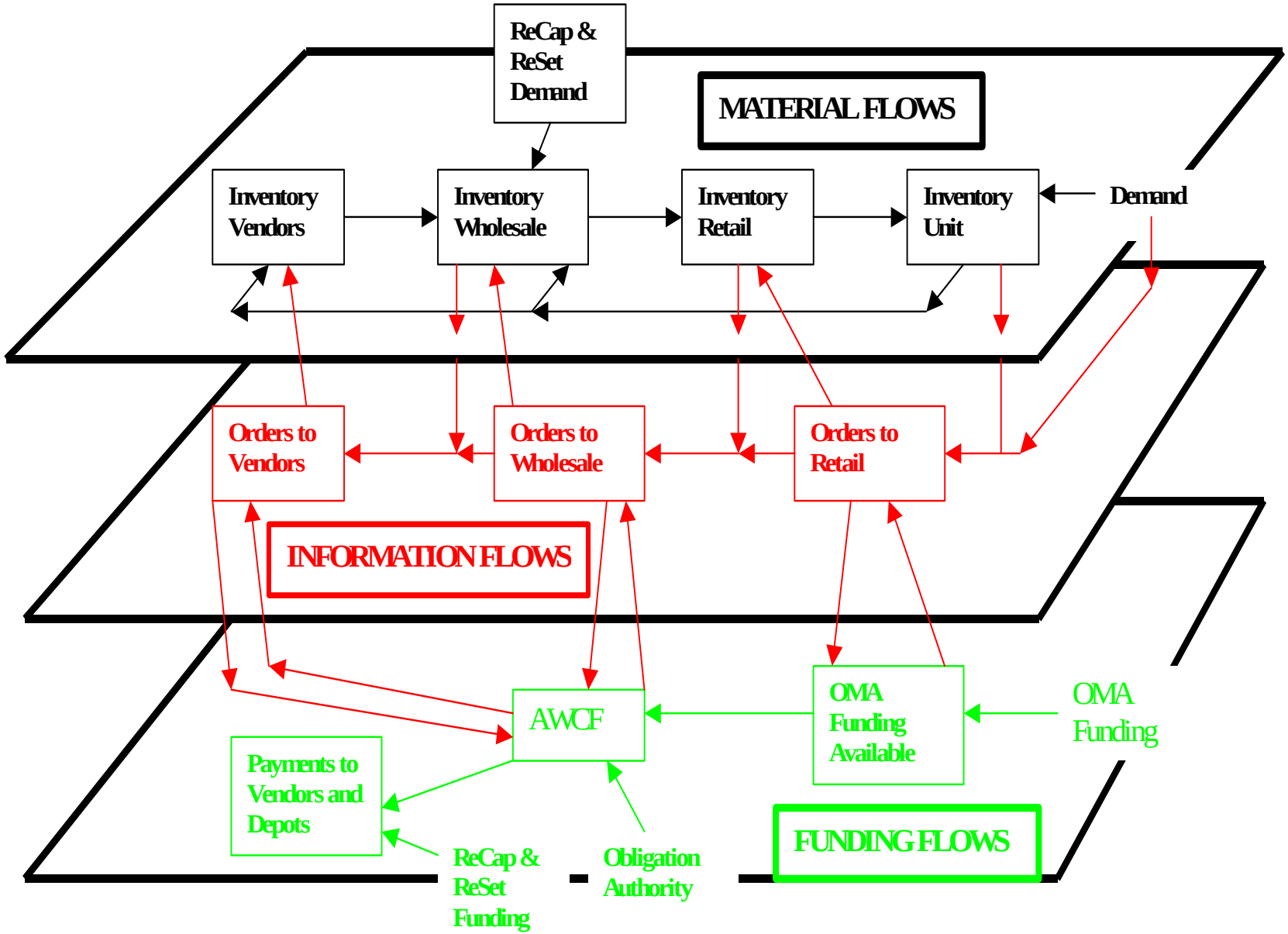
vs

Logistics Chain Integration

(Optimizing the system)

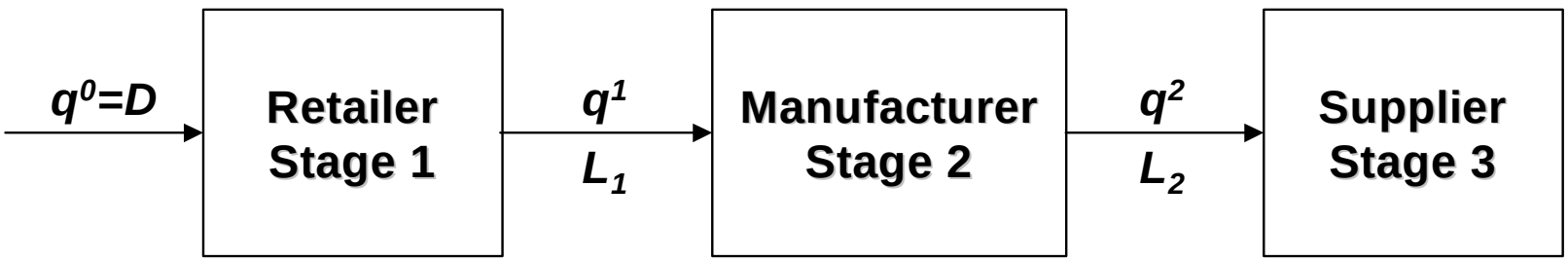


Service levels can actually be increased while simultaneously reducing inventory levels, safety stock and aggregate RO


ReCap & ReSet Demand
MATERIAL FLOWS
Inventory Vendors
Inventory Wholesale
Inventory Retail
Inventory Unit
Demand
Orders to Vendors
Orders to Wholesale
Orders to Retail
INFORMATION FLOWS
AWCF
OMA Funding Available
OMA Funding
Payments to Vendors and Depots
ReCap & ReSet Funding
Obligation Authority
FUNDING FLOWS

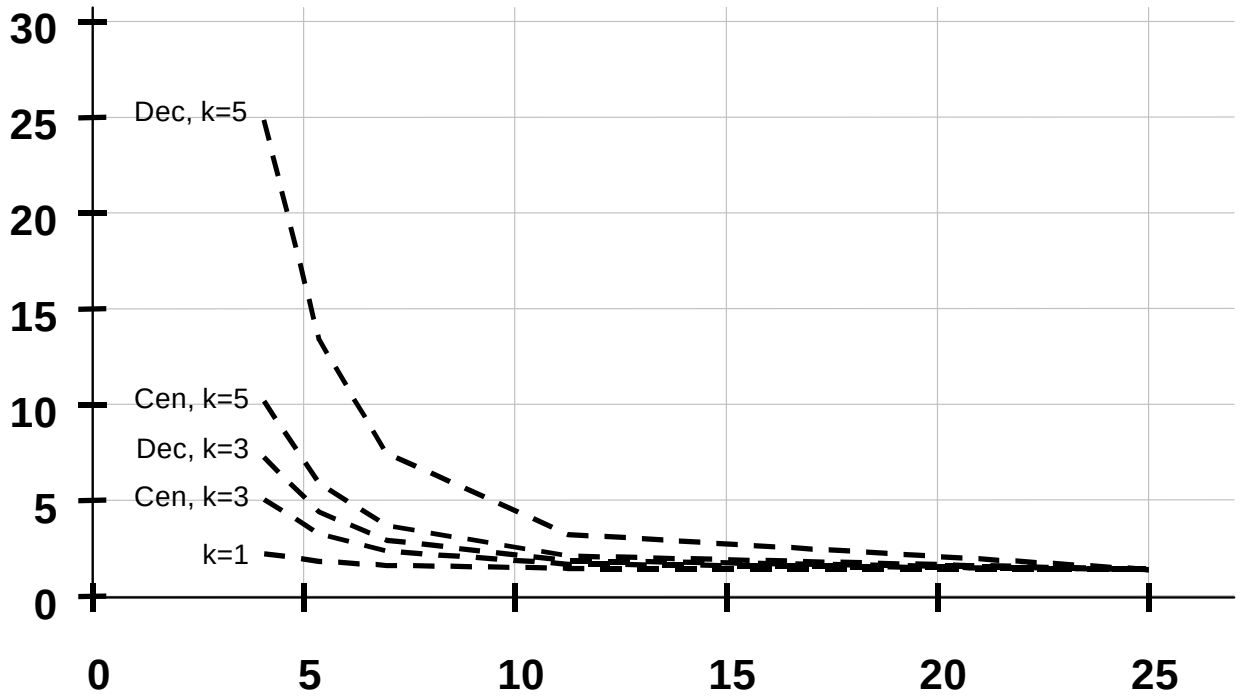
Multi-stage Supply Chains

- **Consider a multi-stage supply chain:**
  - **Stage *i* places order q^i to stage *i+1*.**
  - **L^i is lead time between stage *i* and *i+1*.**

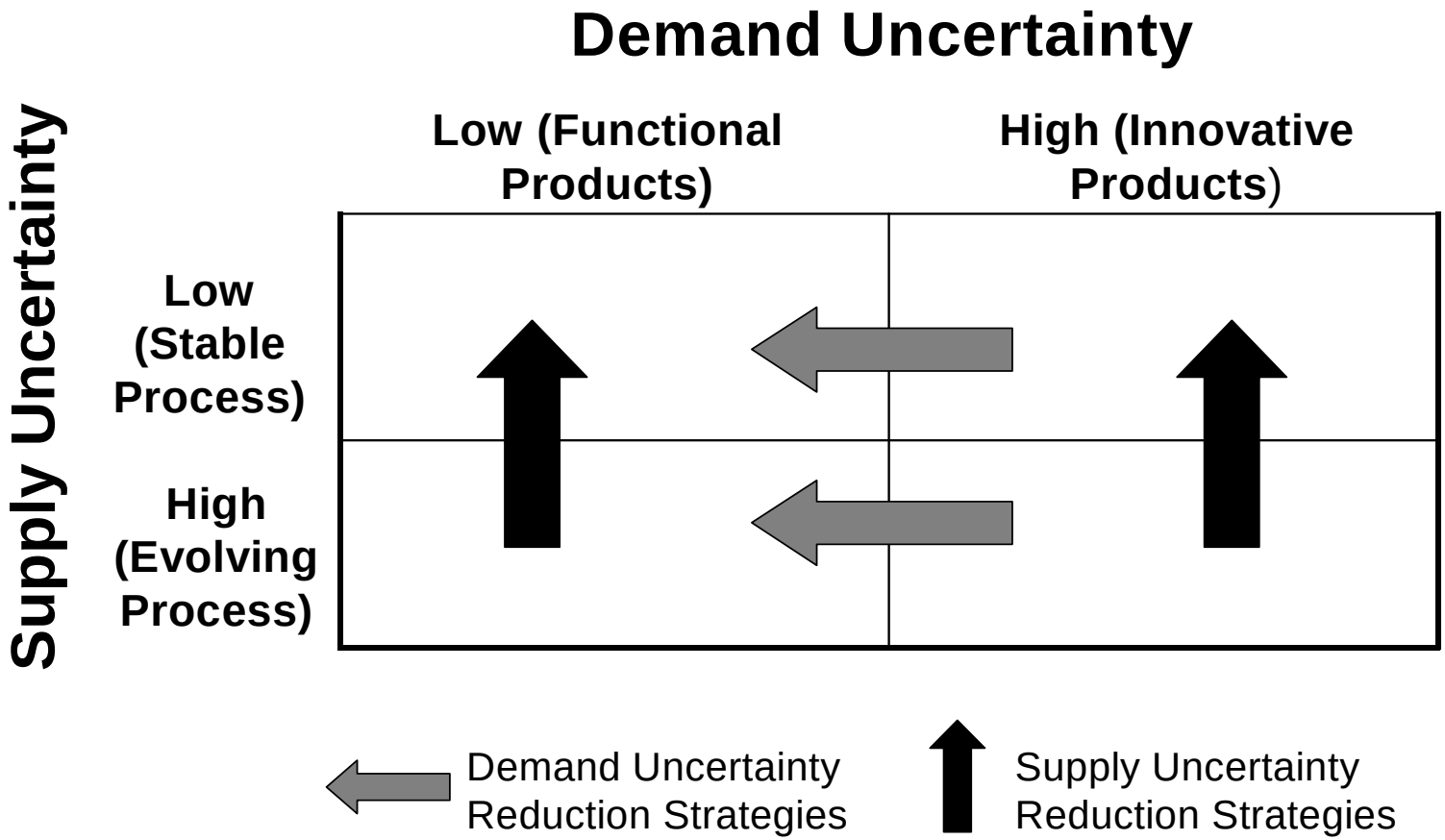


Source: MIT

Multi-stage Systems: Var(q^k)/Var(D)



Source: Simchi-Levi


Demand Uncertainty
Low (Functional Products)
High (Innovative Products)
Supply Uncertainty
Low (Stable Process)
High (Evolving Process)
Demand Uncertainty Reduction Strategies
Supply Uncertainty Reduction Strategies

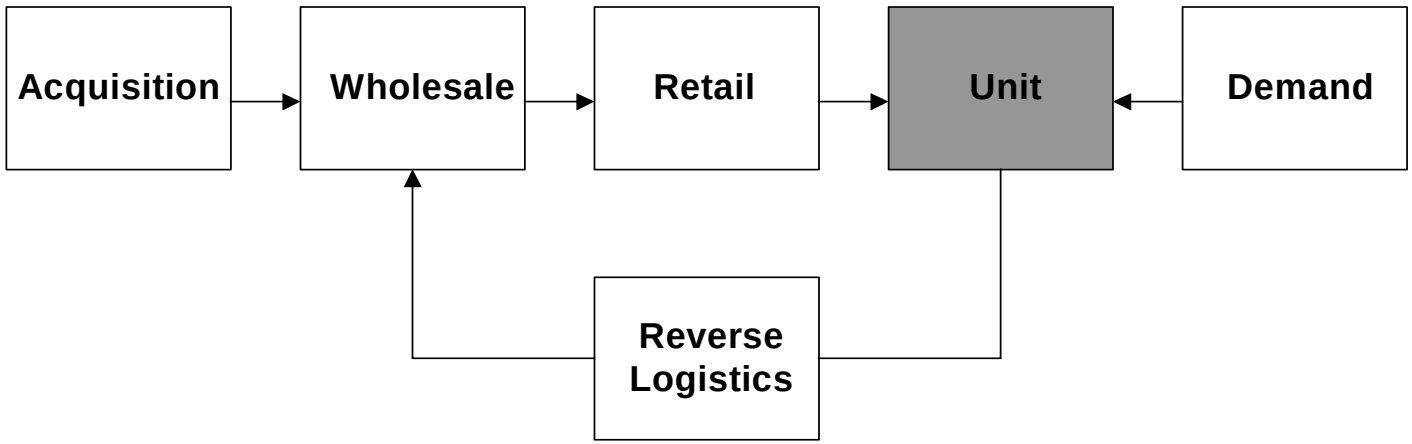
Demand Uncertainty

Supply Uncertainty	Low (Functional Products)	High (Innovative Products)
Low (Stable Process)	Efficient supply chains	Responsive supply chains
High (Evolving Process)	Risk-hedging supply chains	Agile supply chains

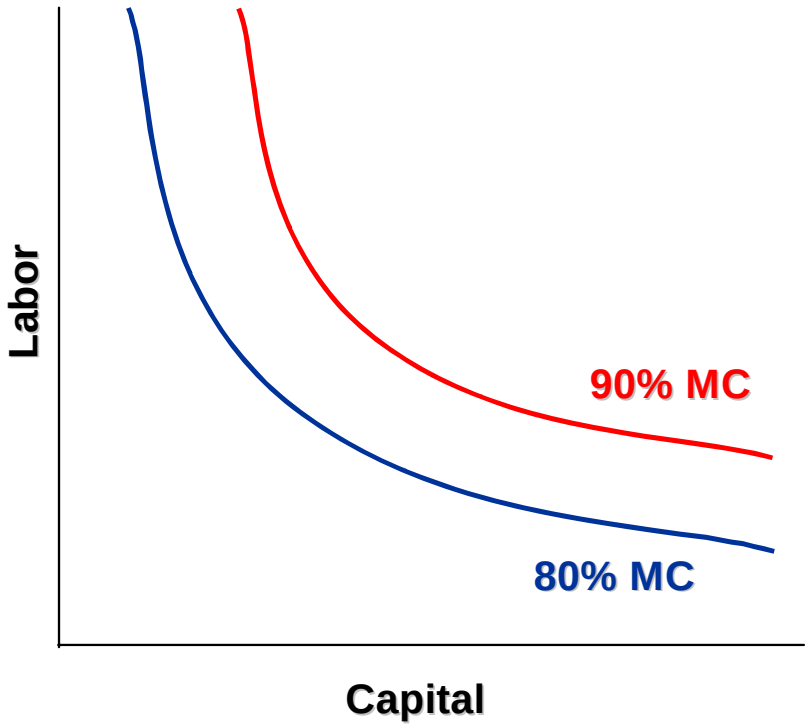
III. Multi-stage Approach - Analysis of Systemic Challenges

1. Readiness Production Stage
2. Operational Mission and Training Demand Stage
3. Retail Stage
4. Retrograde/Reverse Logistics Stage
5. Wholesale/Depot Stage
6. Acquisition Stage

Conceptual Model of Logistics Structure



The "Production Function" for "Readiness":
Defining and Quantifying the Availability Equation



$$A_O = \frac{\text{Uptime}}{\text{Total Time}}$$

$$= \frac{\text{MTBF x K}}{\text{(MTBF x K) + MTTR + MLDT}}$$

Where

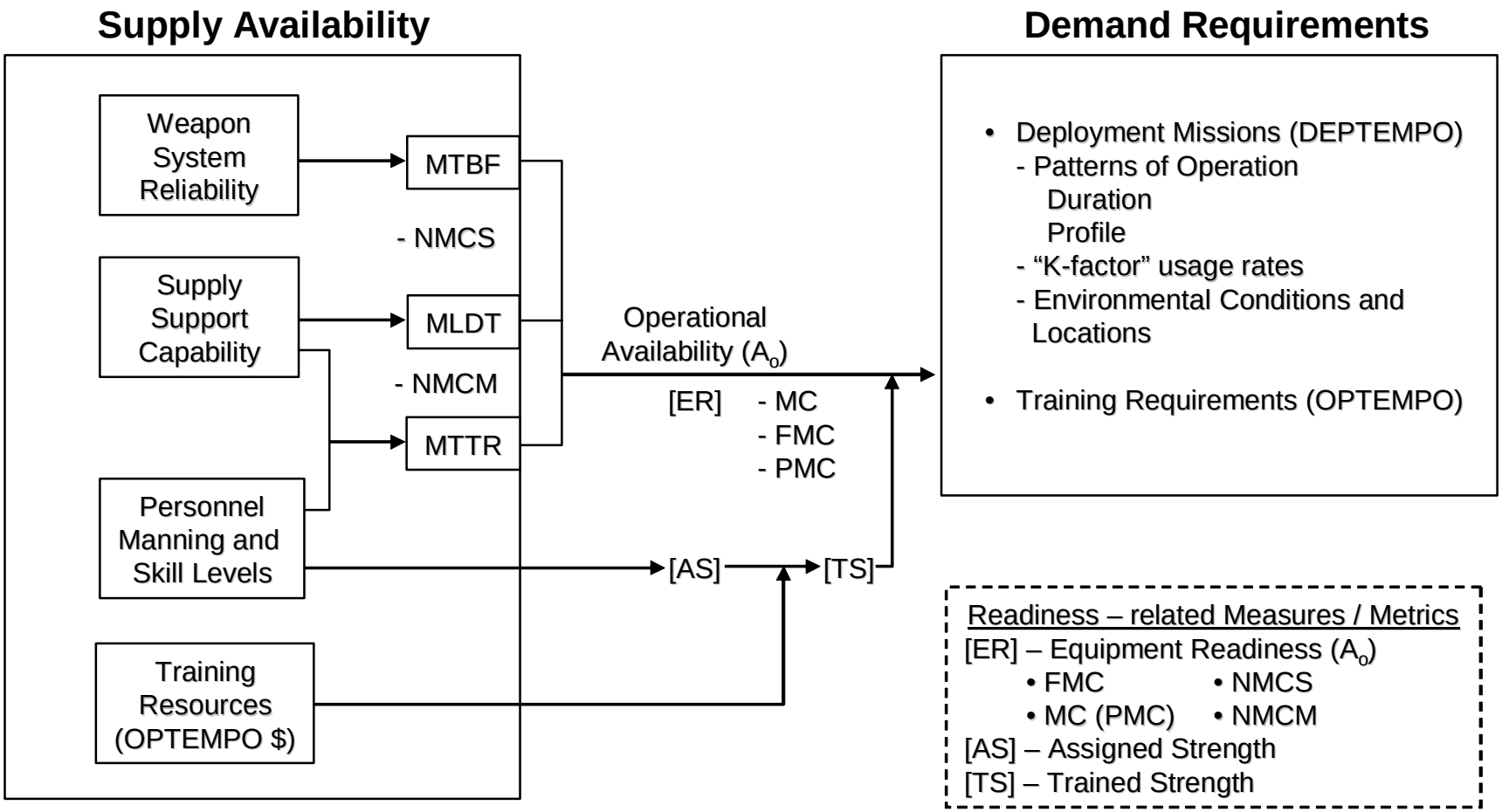
MTBF = Mean Time Between Failures (Reliability)

K = Ratio of Calendar Time to Equipment Operating Time (Duty Factor)

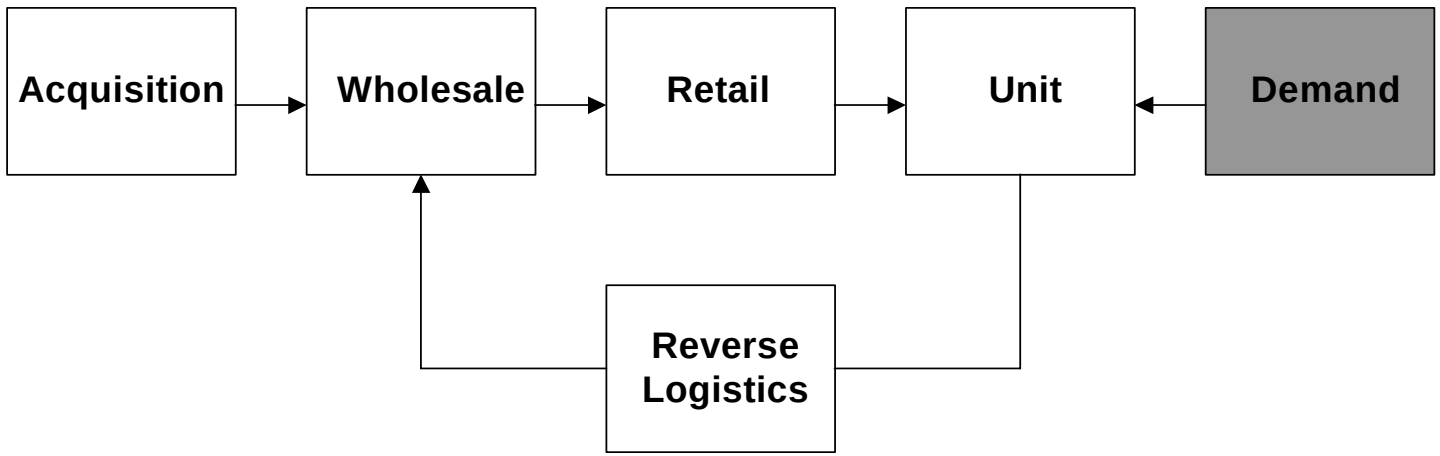
MTTR = Mean Time To Repair (Maintainability)

MLDT = Mean Logistics Delay Time (Supportability)

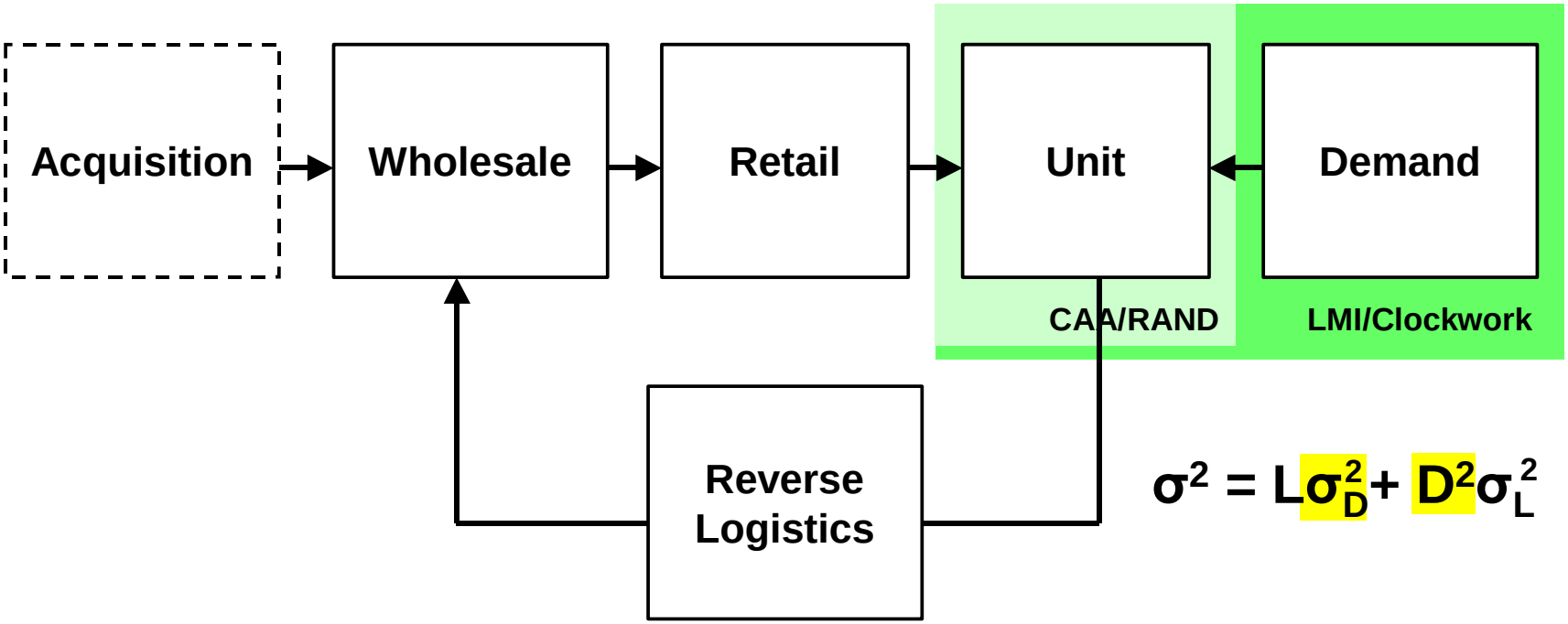
"Production Function": Components of Readiness



Conceptual Model of Logistics Structure



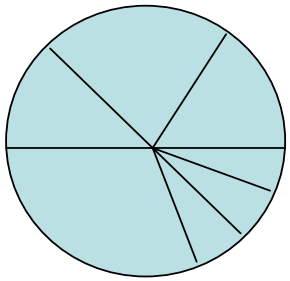
Enhanced Class IX Planning:
Linking Operational Patterns, Demand Forecasting, and Supply/Acquisition Planning (See Annex B)



- Reduce Demand Uncertainty and Variability by Improving Requirements Estimation and Spares Forecasting
- Reconfigure the Logistics Chain to Reduce the Costs of Demand Uncertainty
- Transition from “Supply Chain” Concept to a “Demand Network”

STRATIFIED SAMPLING

POPULATION OF SIZE **N** DIVIDED INTO **K** STRATA



RANDOM SAMPLING: $\hat{P}_{RSM} = \frac{x}{n}$

STRATIFIED SAMPLING: $P_k^1 = \frac{x_k}{n_k}$

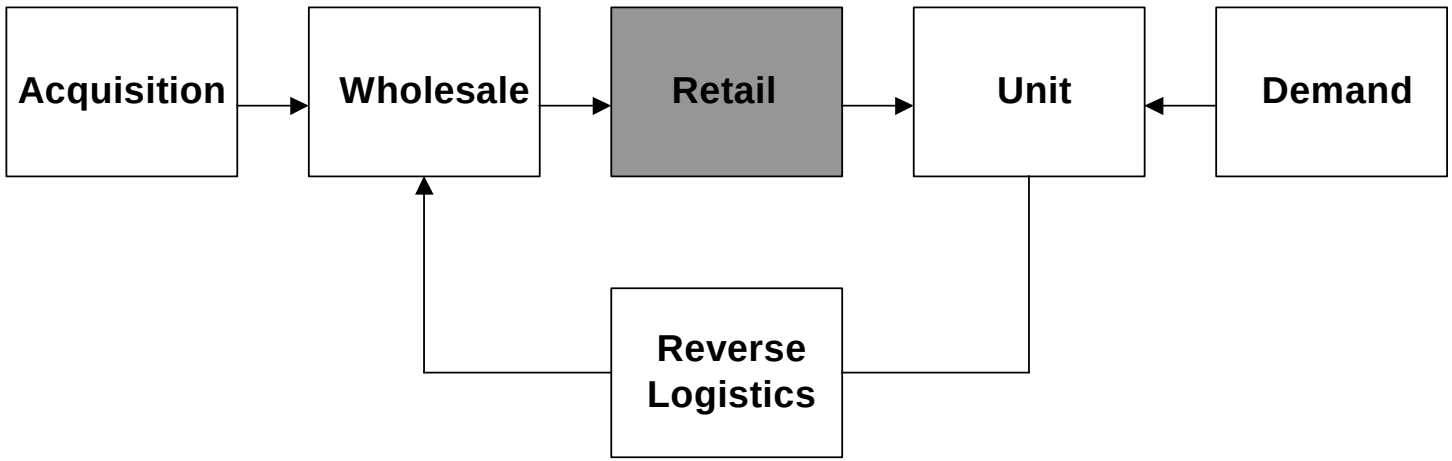
THEN:

$$\hat{P}_{STRAT} = \frac{\sum_{i=1}^{k} N_k P_k^1}{N}$$

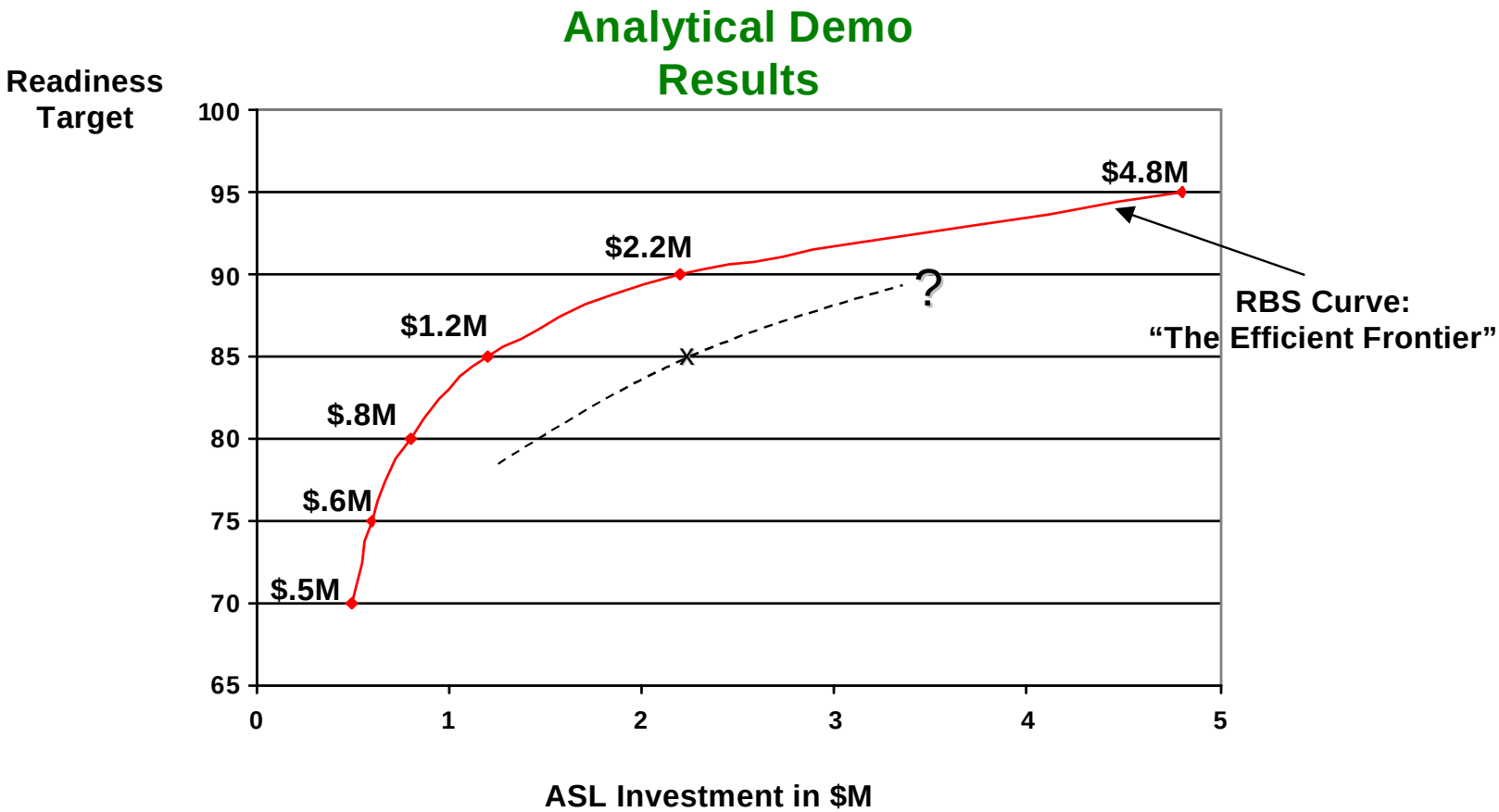
USUALLY:

$$Var\left(\hat{\Theta}_{STRAT}\right) \leq Var\left(\Theta_{POP}\right) \leq Var\left(\hat{\Theta}_{RSM}\right)$$

Conceptual Model of Logistics Structure

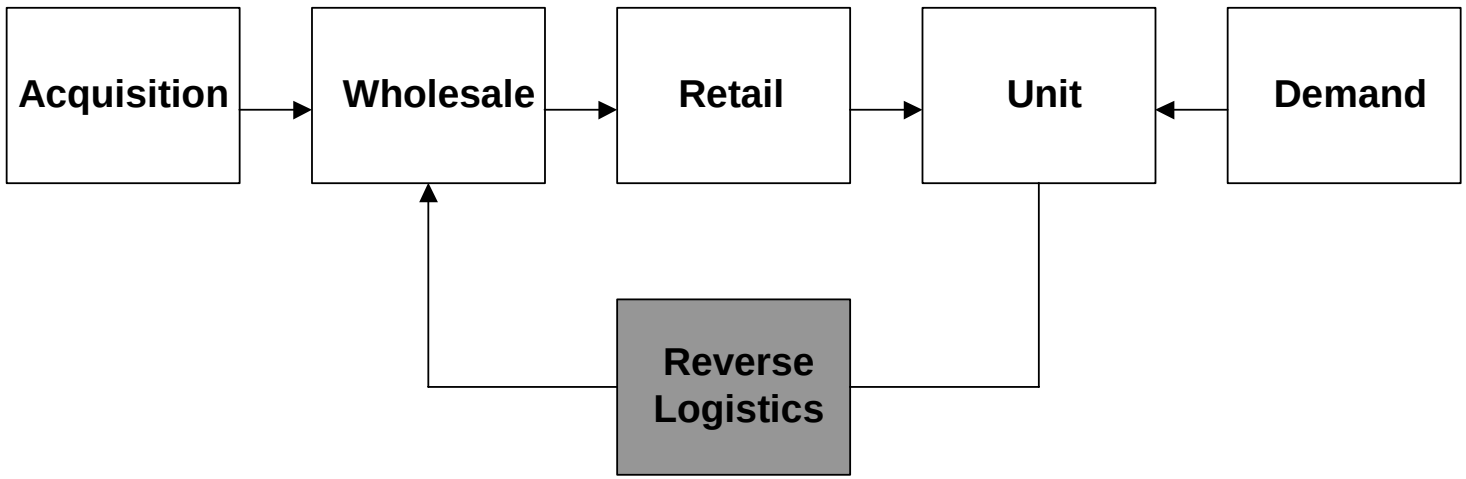


Readiness Based Sparing at 101st Airborne - Blackhawk Parts

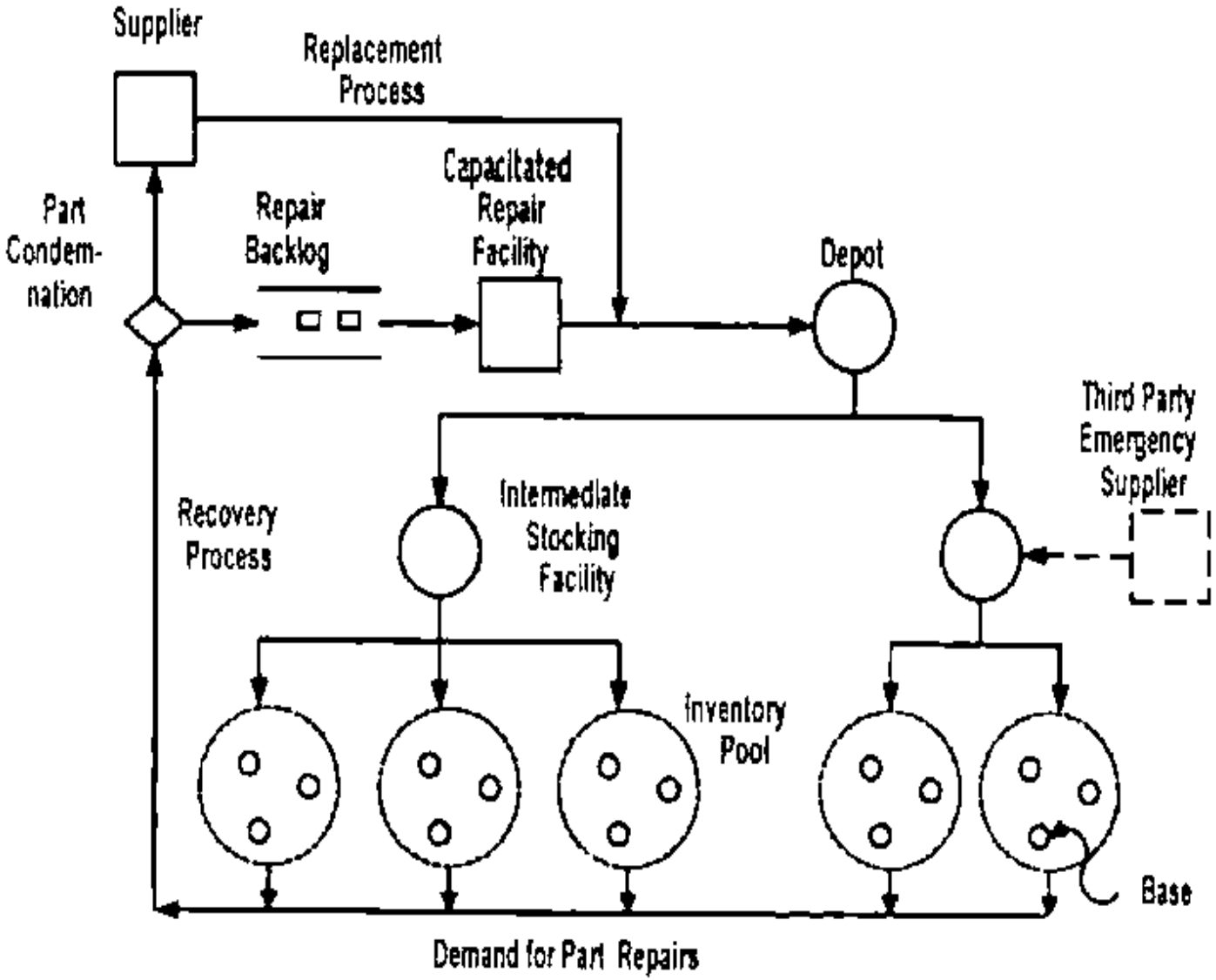


Source: AMSAA

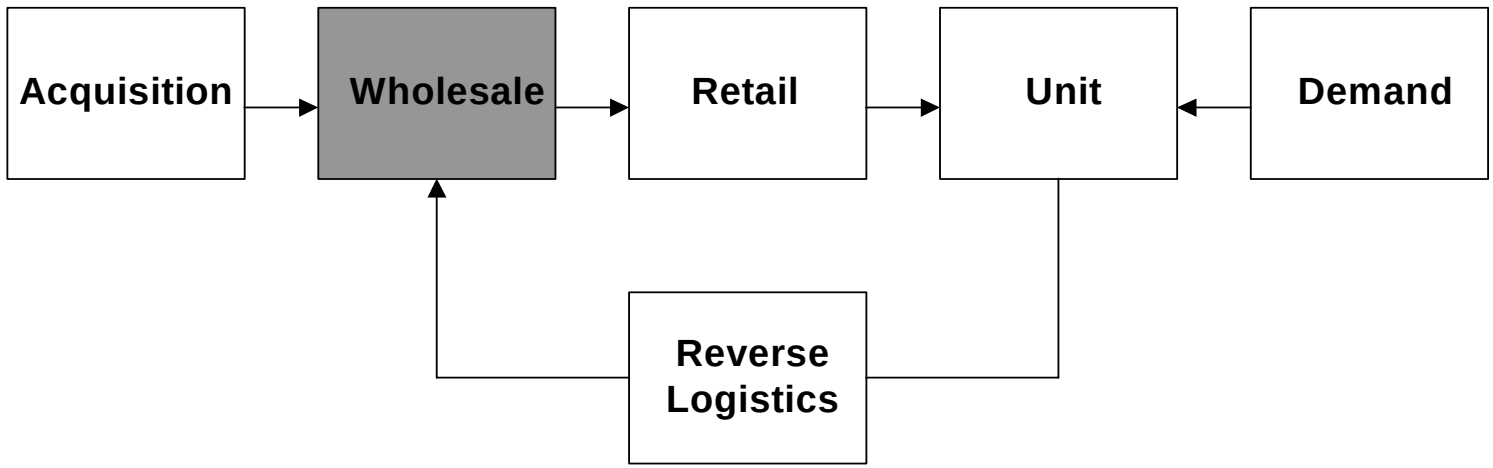
Conceptual Model of Logistics Structure



Reverse Logistics Structure



Conceptual Model of Logistics Structure



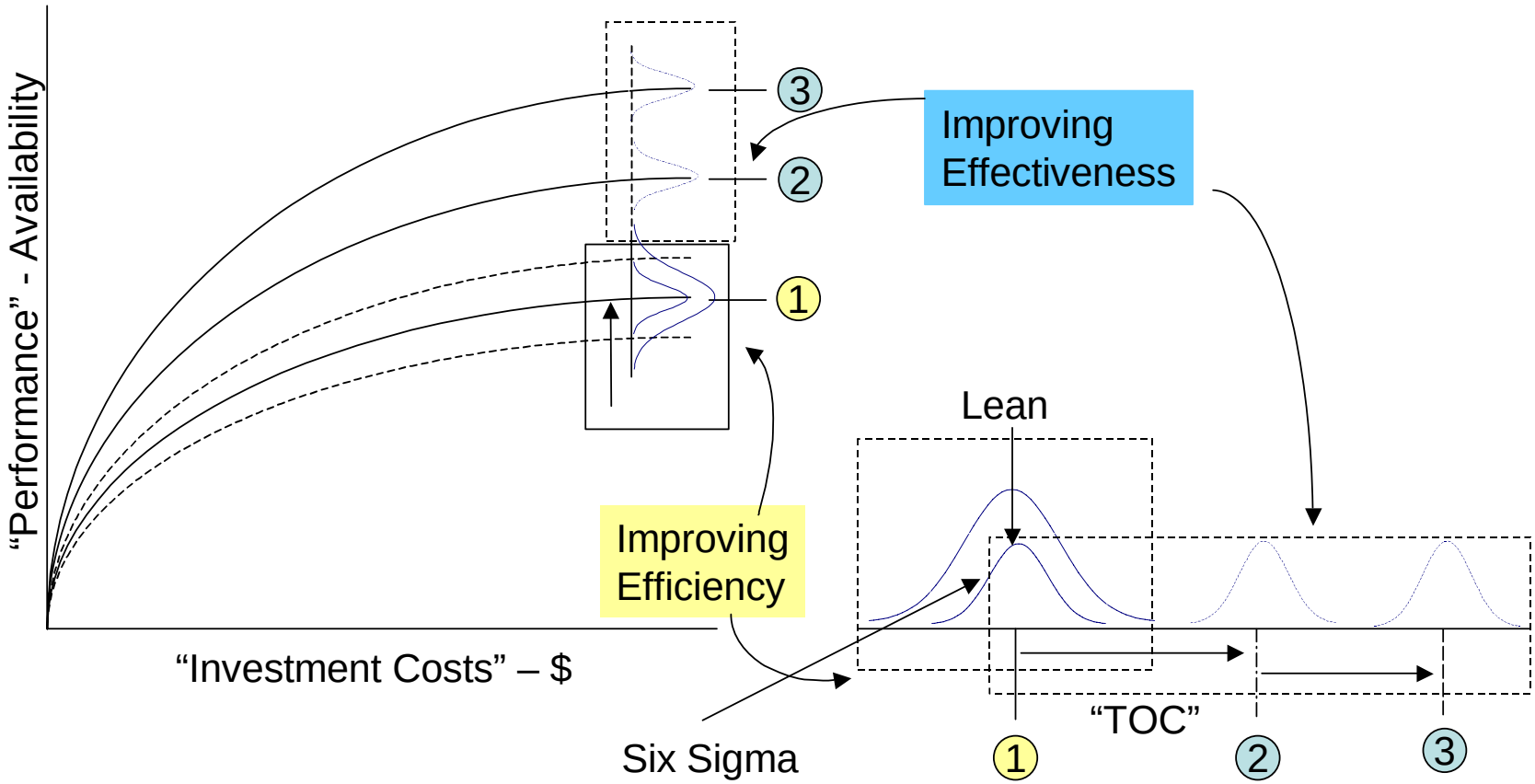
SIX SIGMA, LEAN AND THEORY OF CONSTRAINTS:

CONTRIBUTIONS IN THE COST-PERFORMANCE TRADESPACE

Six Sigma – improving product quality (fewer defects) by reducing process variation (variation reduction)

Lean – synchronizing process flow (“takt” time) by removing excess WIP (inventory reduction)

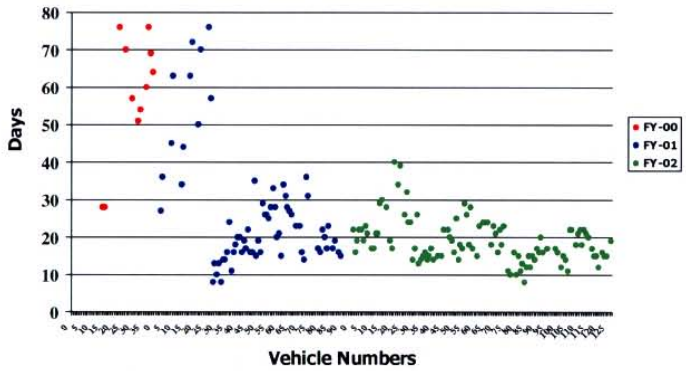
Theory of Constraints – improving cost effectiveness by strengthening weak links (constraint reduction)



MATCOM

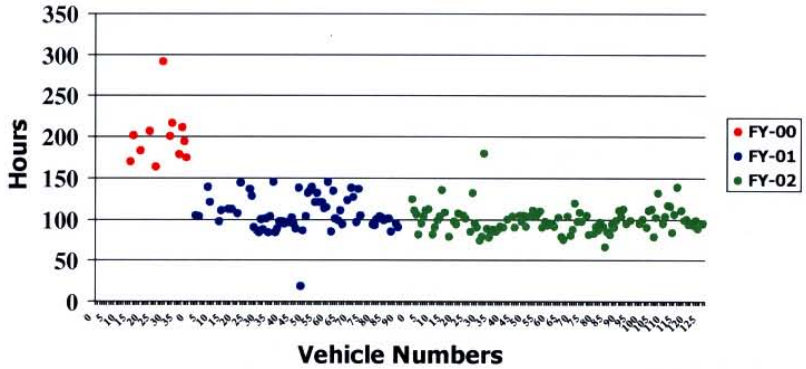
MK-48 Engine

Repair Cycle Time (Days)



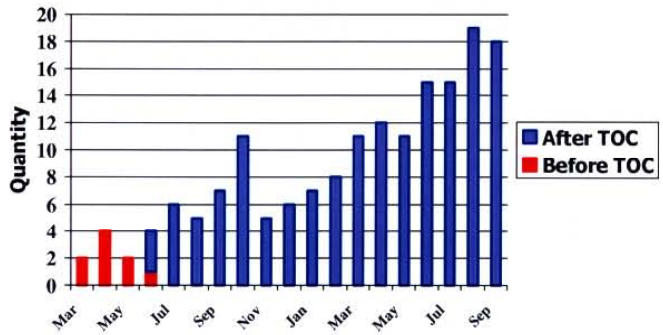
Data Source: Concerto Activity By Project Records

Labor Hours



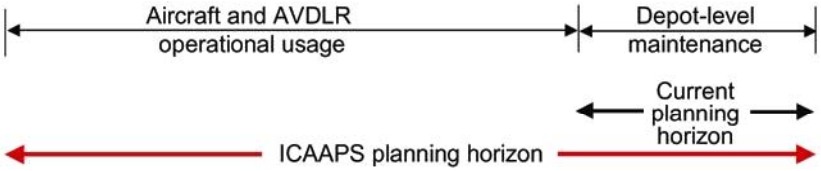
Data Source: Essex Replacement Program (ERP)

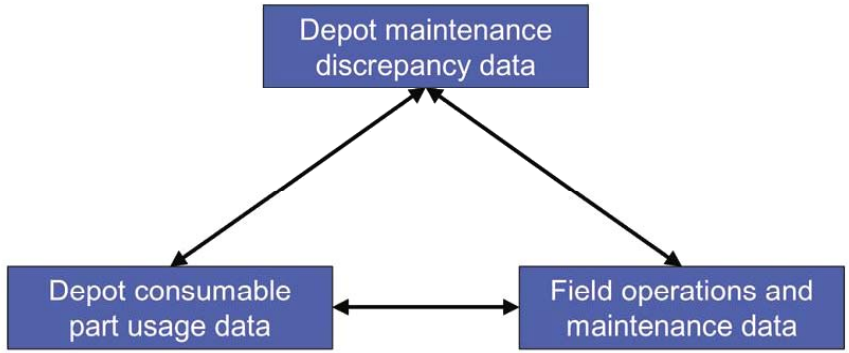
Output Per Month

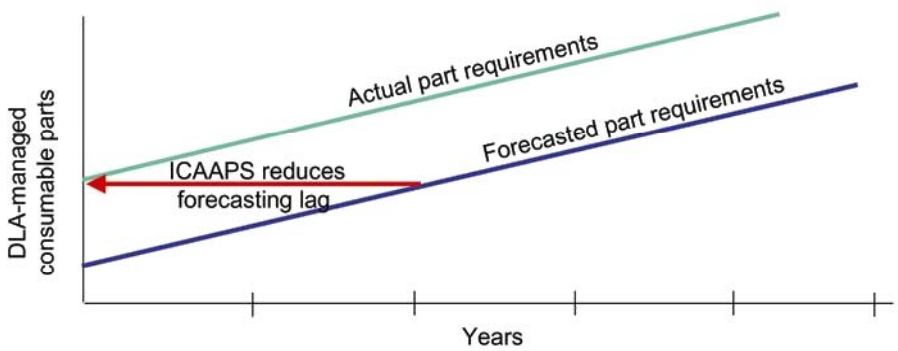


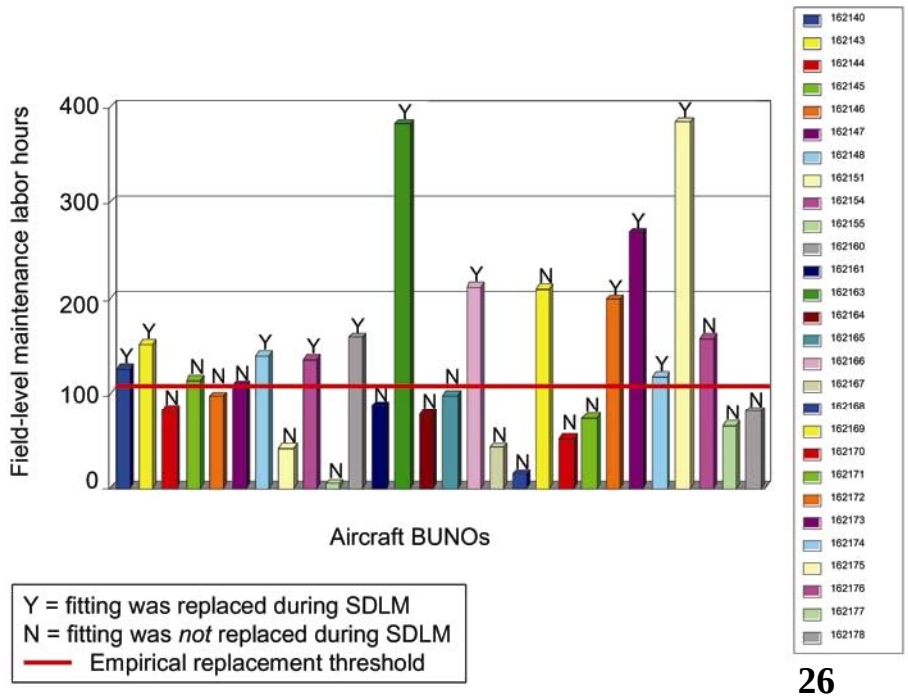
Data Source: Concerto Activity By Project Records

ICAAPS: Intelligent Collaborative Aging Aircraft Parts Support (LMI)



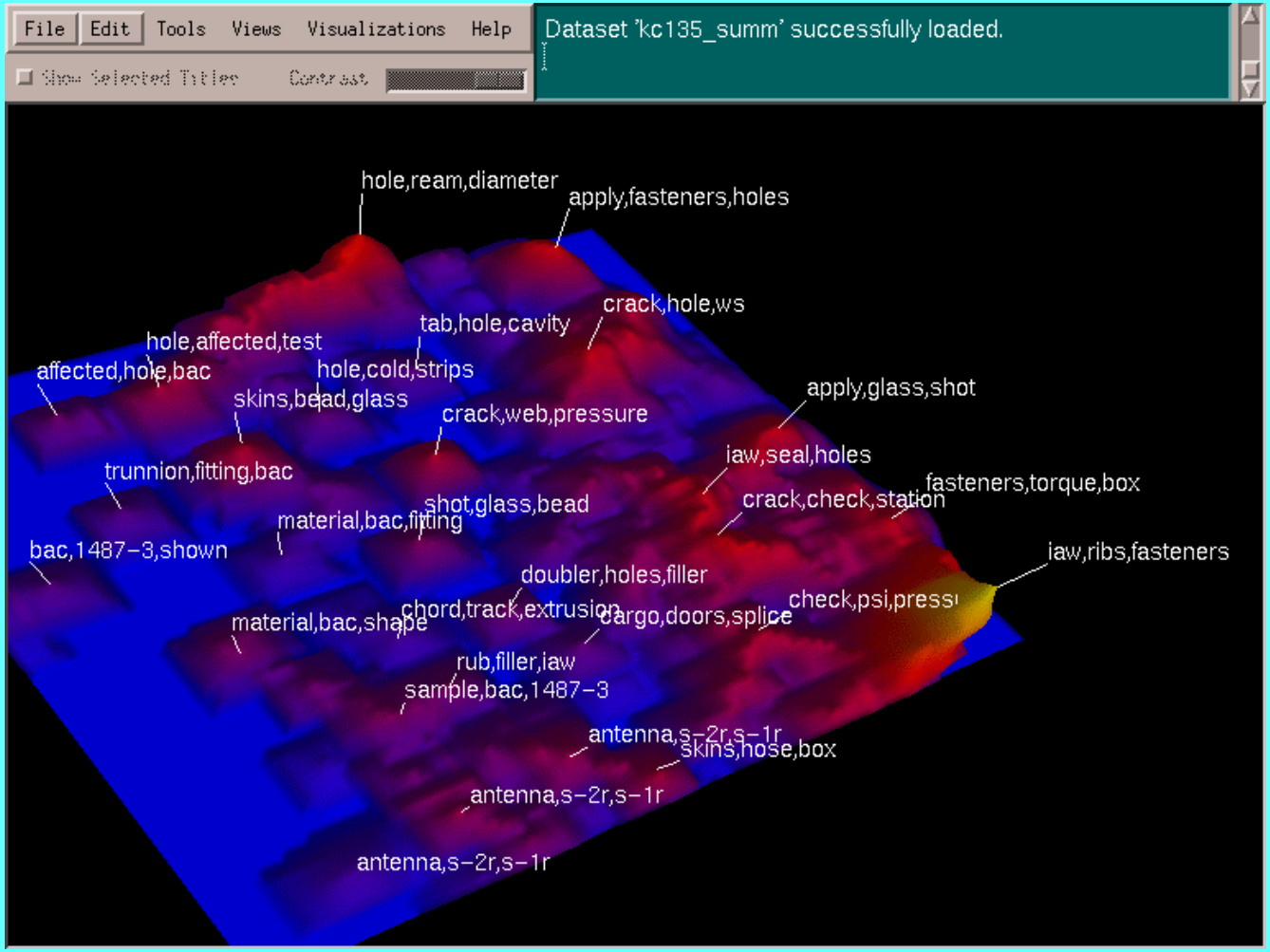






SPIRE 'Themescape' view of KC135 Maintenance Data

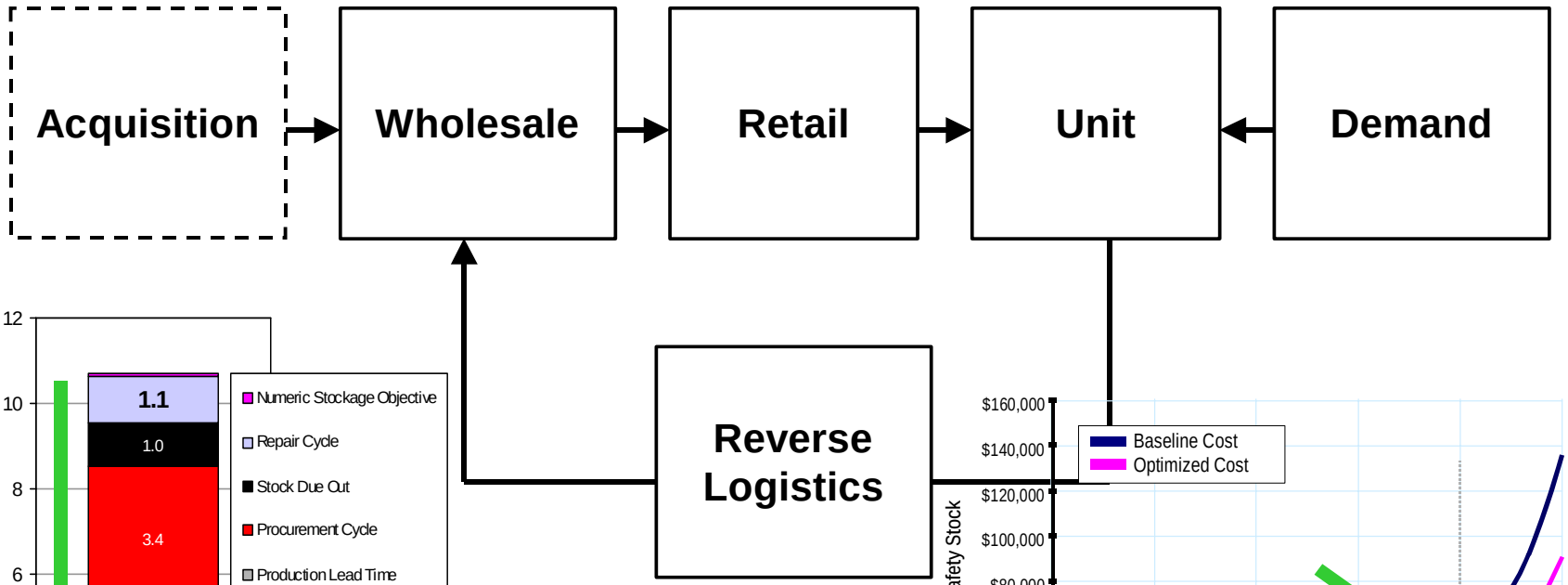
Partnering for the Future
IS&E
Information Sciences and Engineering

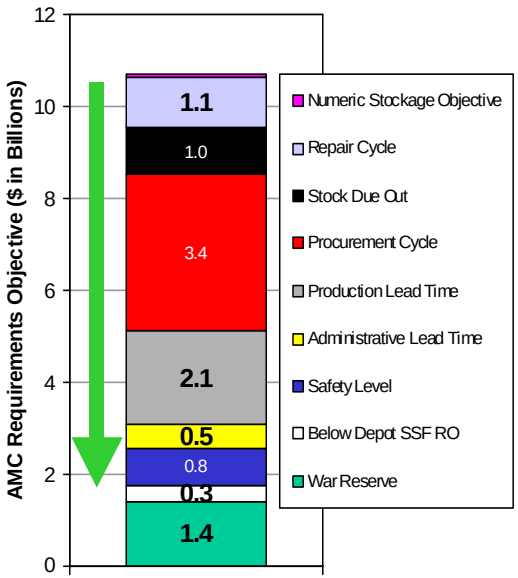


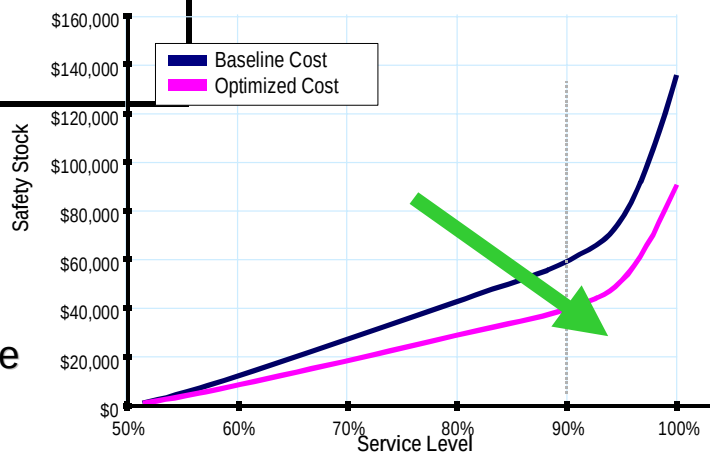
Battelle

U.S. Department of Energy
Pacific Northwest National Laboratory

Improving System Efficiency: Across the System of Stages and within each Stage

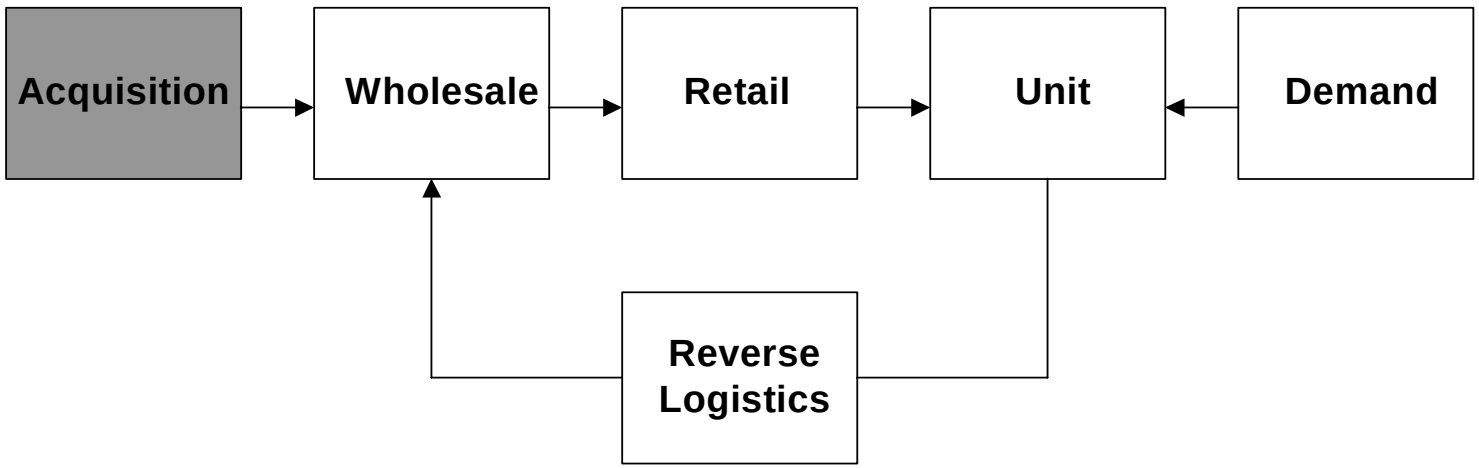






Because inventories are managed to the computed RO, reducing the value of the RO calculated by AMC's models is a critical first step to reducing inventories.
Source: RAND AB 185-A

Conceptual Model of Logistics Structure



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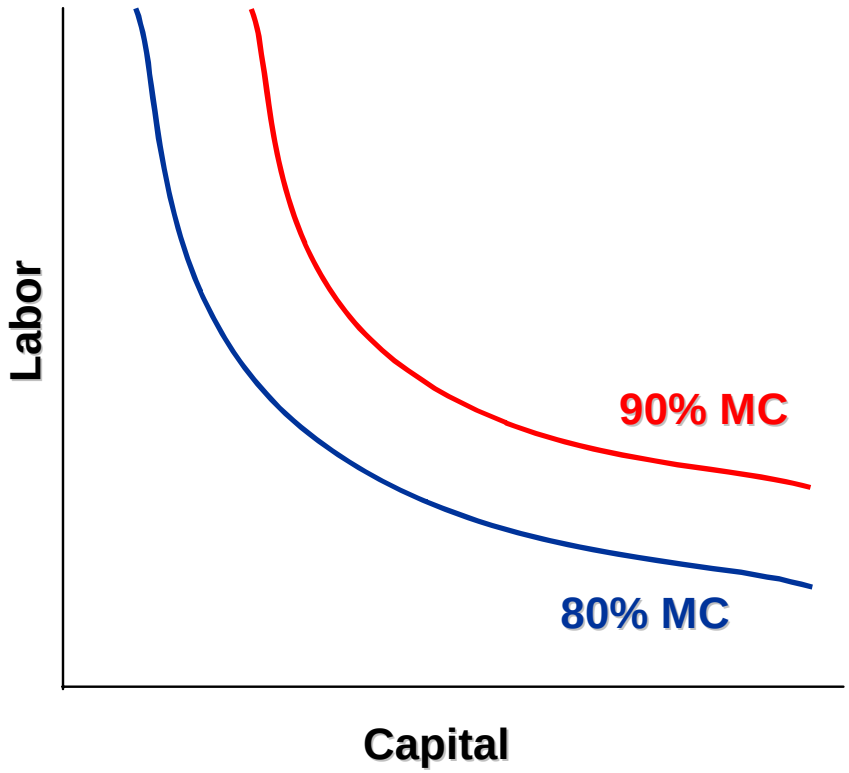
Defining and Quantifying the Availability Equation



$$A_O = \frac{\text{Uptime}}{\text{Total Time}}$$

$$= \frac{\text{MTBF x K}}{\text{(MTBF x K) + MTTR + MLDT}}$$

Where

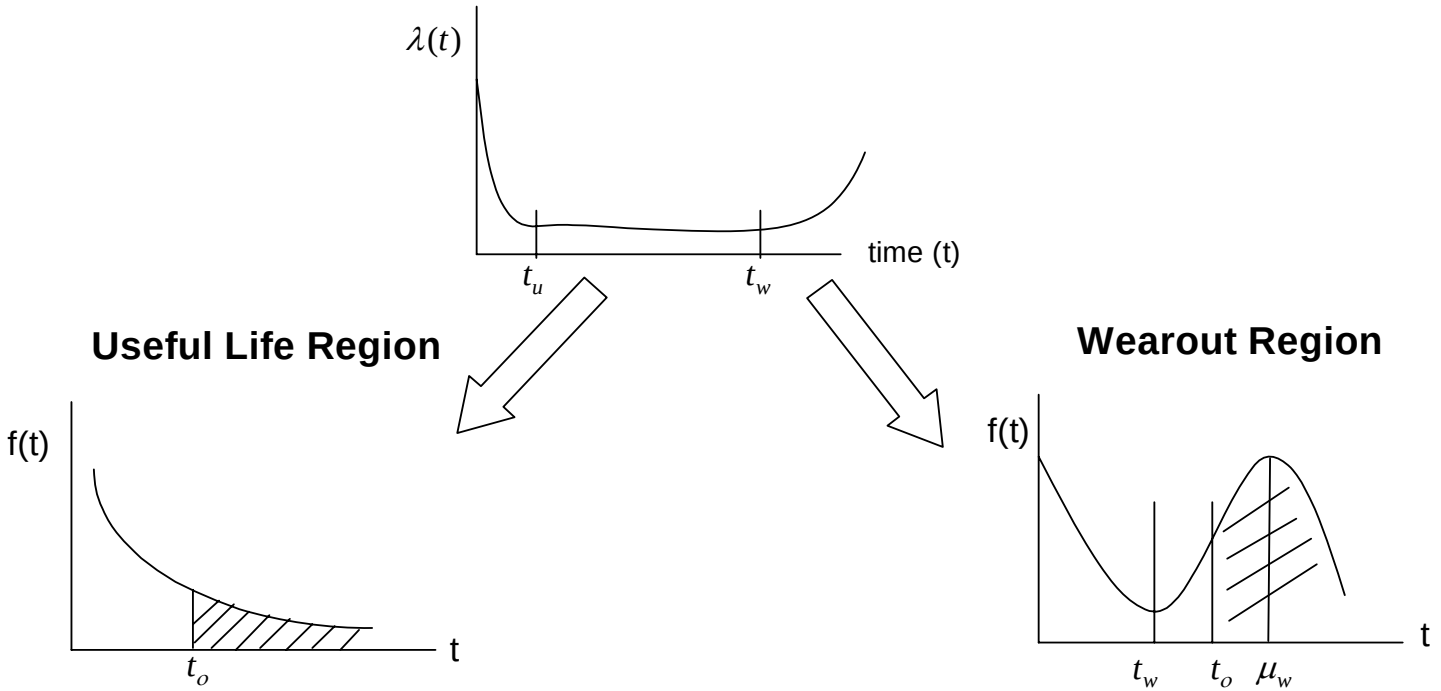
MTBF = Mean Time Between Failures (Reliability)

K = Ratio of Calendar Time to Equipment Operating Time (Duty Factor)

MTTR = Mean Time To Repair (Maintainability)

MLDT = Mean Logistics Delay Time (Supportability)

System Life Cycle Failure Rate Pattern: The "Bathtub" Curve

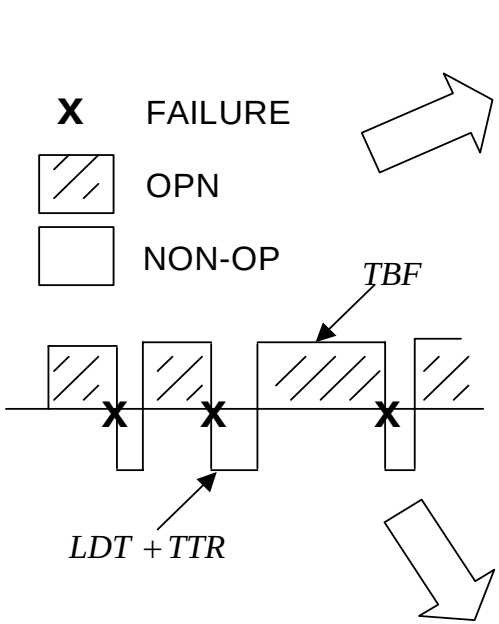


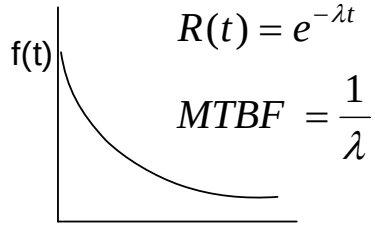
$$P(t > t_o) = 1 - F(t_o)$$
$$= 1 - (1 - e^{-\lambda t_o})$$
$$= e^{-\lambda t_o}$$
$$= R(t_o)$$

$$P(T > t_o) = P(t > t_w) \cap P(t > t_o)$$
$$= P(t > t_w) \times P(T > t_o | t > t_w)$$
$$= R(t_w) R(t_o)$$
$$= e^{-\lambda t_w} \times P\left(Z > \frac{t_o - \mu_w}{\sigma_w} \right)$$

Components of Operational Availability

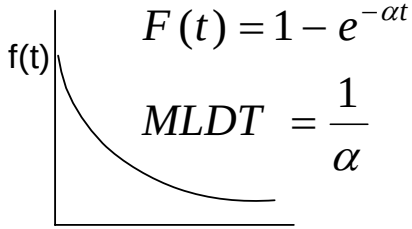
Failure Density





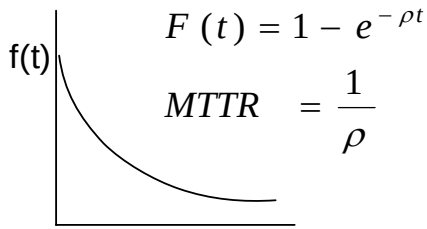
$$A_o = \frac{MTBF}{MTBF + MLDT + MTTR} = \frac{1}{1 + \frac{\lambda}{\alpha} + \frac{\lambda}{\rho}}$$

Supply Support Density

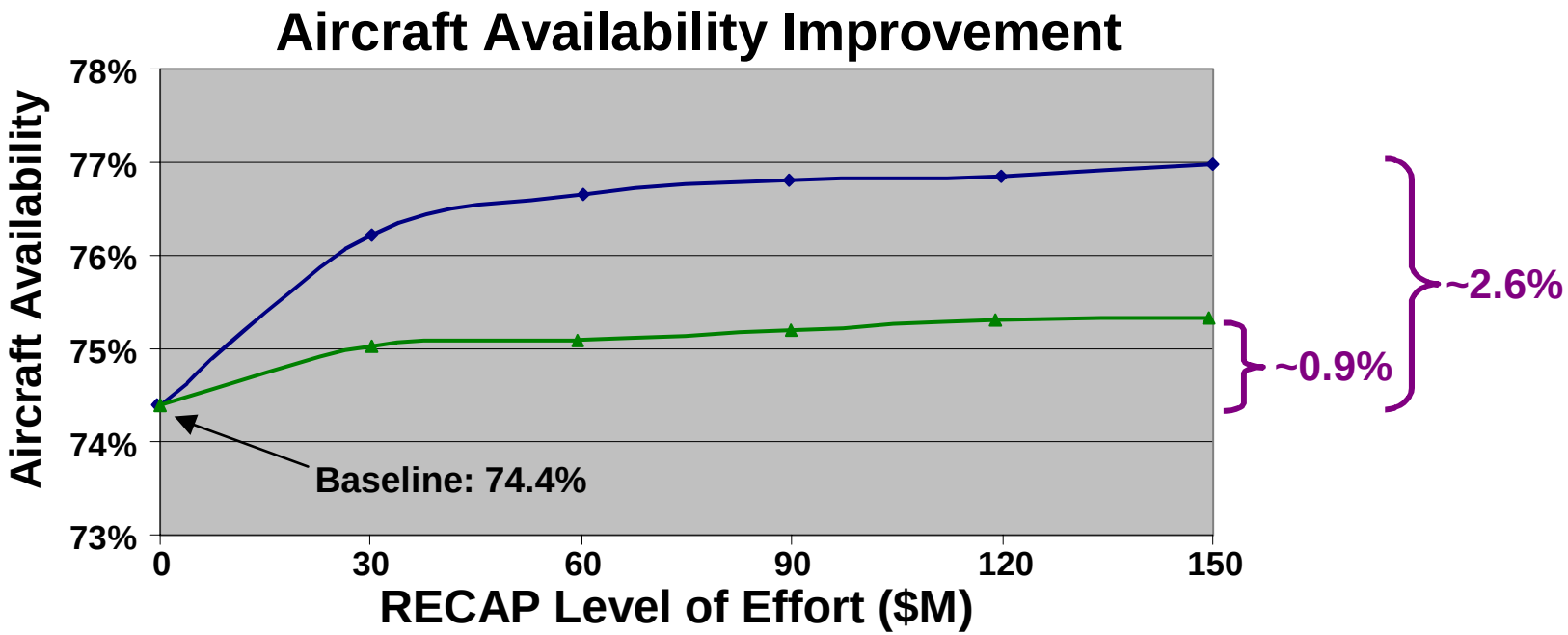


+

Repair Density



Availability Improvement Analyses

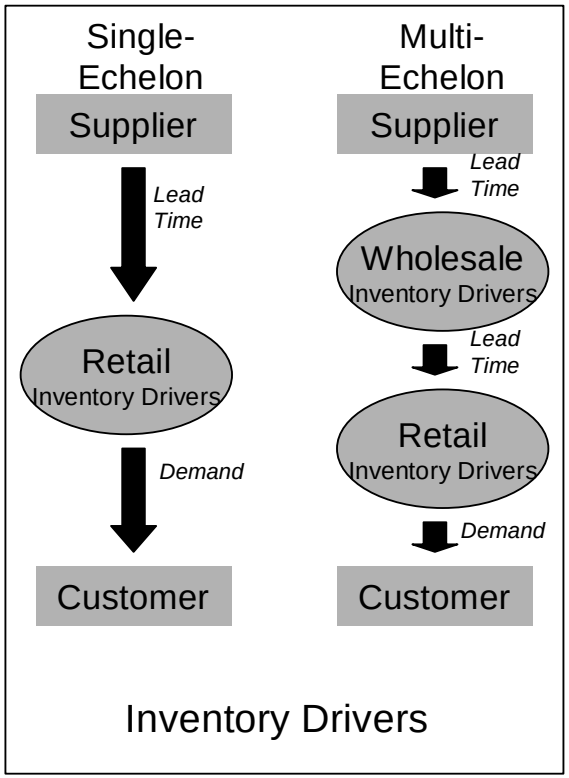


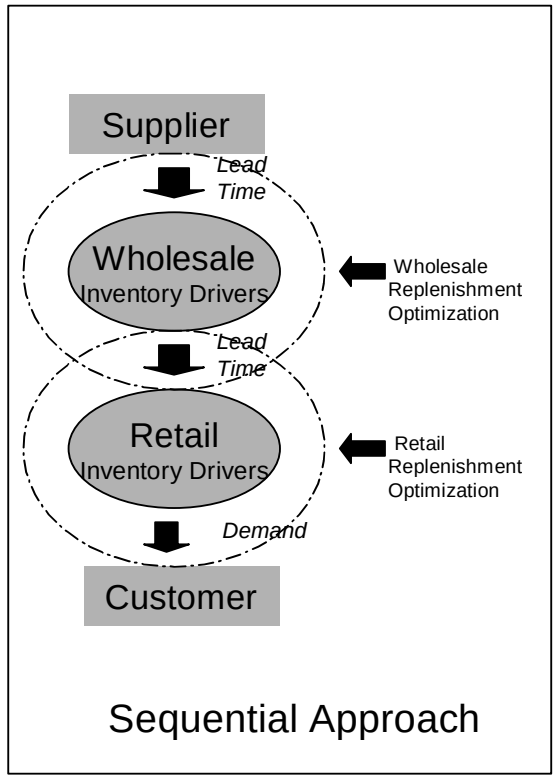
52 RECAP (MTBUR's: 1500 / 2500 / 20% minimum)

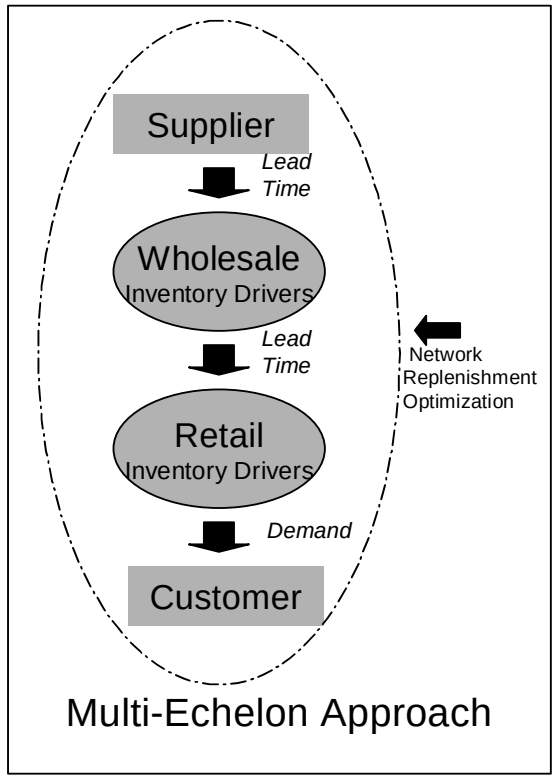
91 Components (MTBUR's: 1500 / 2500 / 20% minimum)

IV. Multi-stage Approach - Integration for Efficiency, Resilience, and Effectiveness

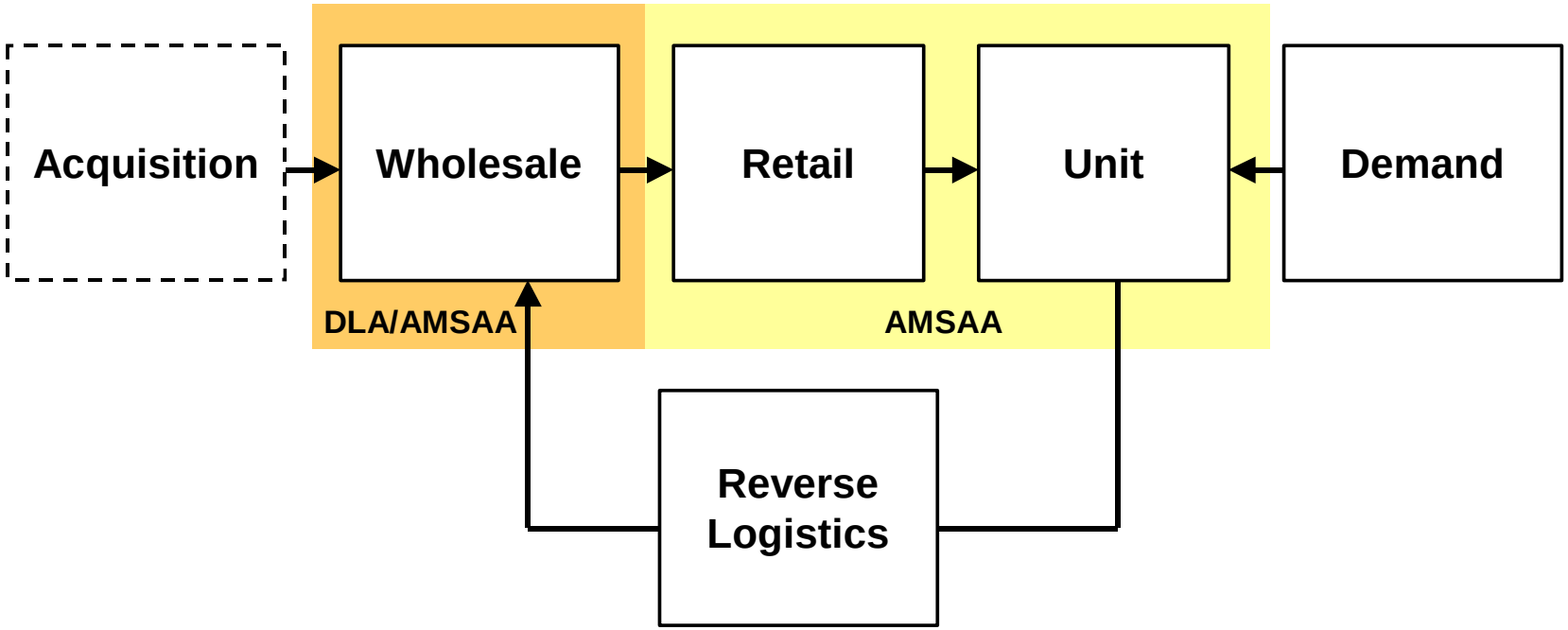
1. Achieving an “Efficient”, Integrated Multi-Echelon Inventory Solution
2. Designing a “Resilient”, Adaptive Logistics Network
3. Improving Logistics “Effectiveness”: Pushing the Performance Envelope
4. Enabling “Effects Based Operations”: Performance Based Logistics
5. An “Analytical Architecture” to Guide Logistics Transformation


Single-Echelon
Supplier
Lead Time
Retail
Inventory Drivers
Demand
Customer
Multi-Echelon
Supplier
Lead Time
Wholesale
Inventory Drivers
Lead Time
Retail
Inventory Drivers
Demand
Customer
Inventory Drivers


Supplier
Lead Time
Wholesale
Inventory Drivers
Wholesale Replenishment Optimization
Lead Time
Retail
Inventory Drivers
Retail Replenishment Optimization
Demand
Customer
Sequential Approach

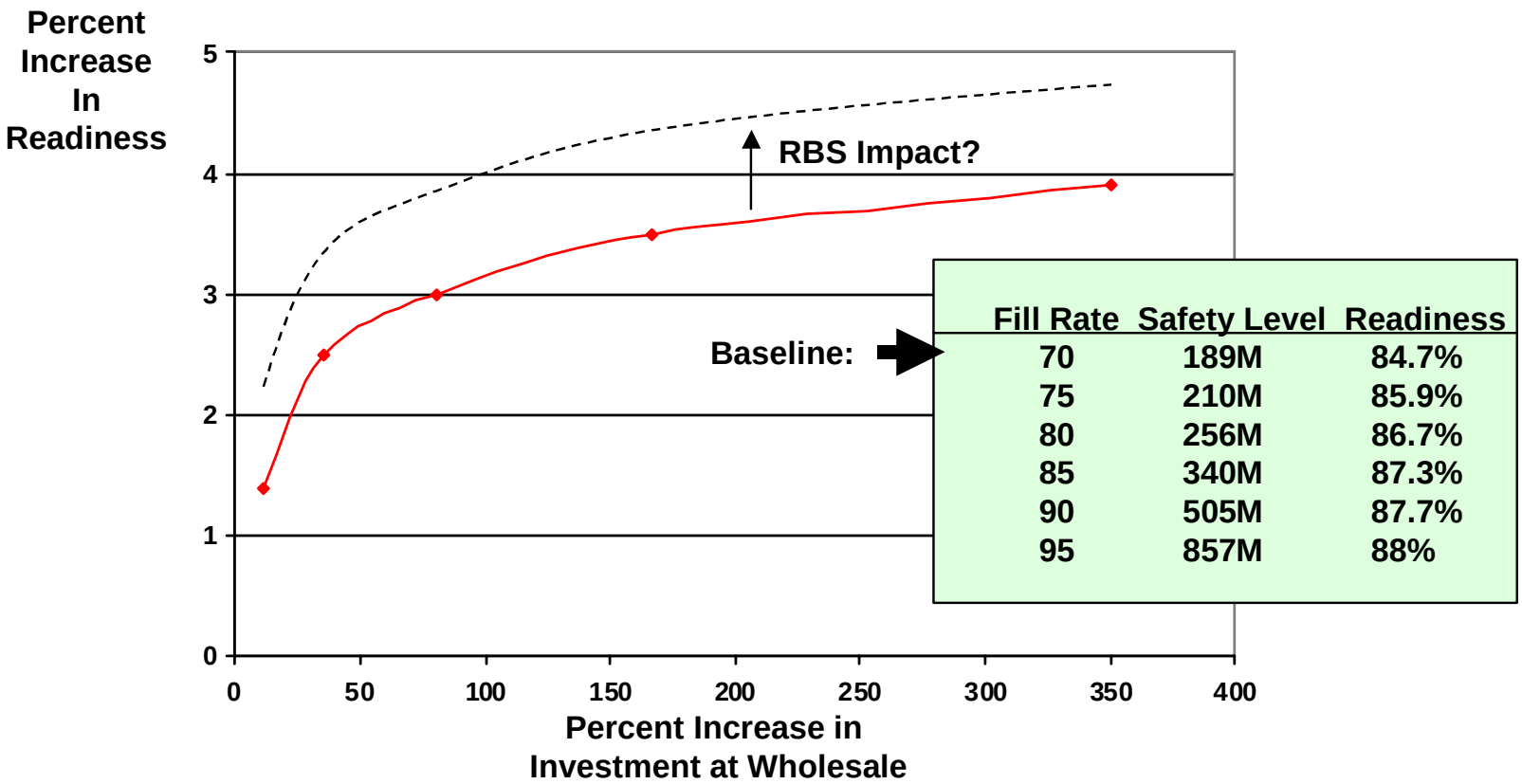

Supplier
Lead Time
Wholesale
Inventory Drivers
Lead Time
Retail
Inventory Drivers
Demand
Customer
Network Replenishment Optimization
Multi-Echelon Approach

Optimizing the Wholesale Stage to Retail



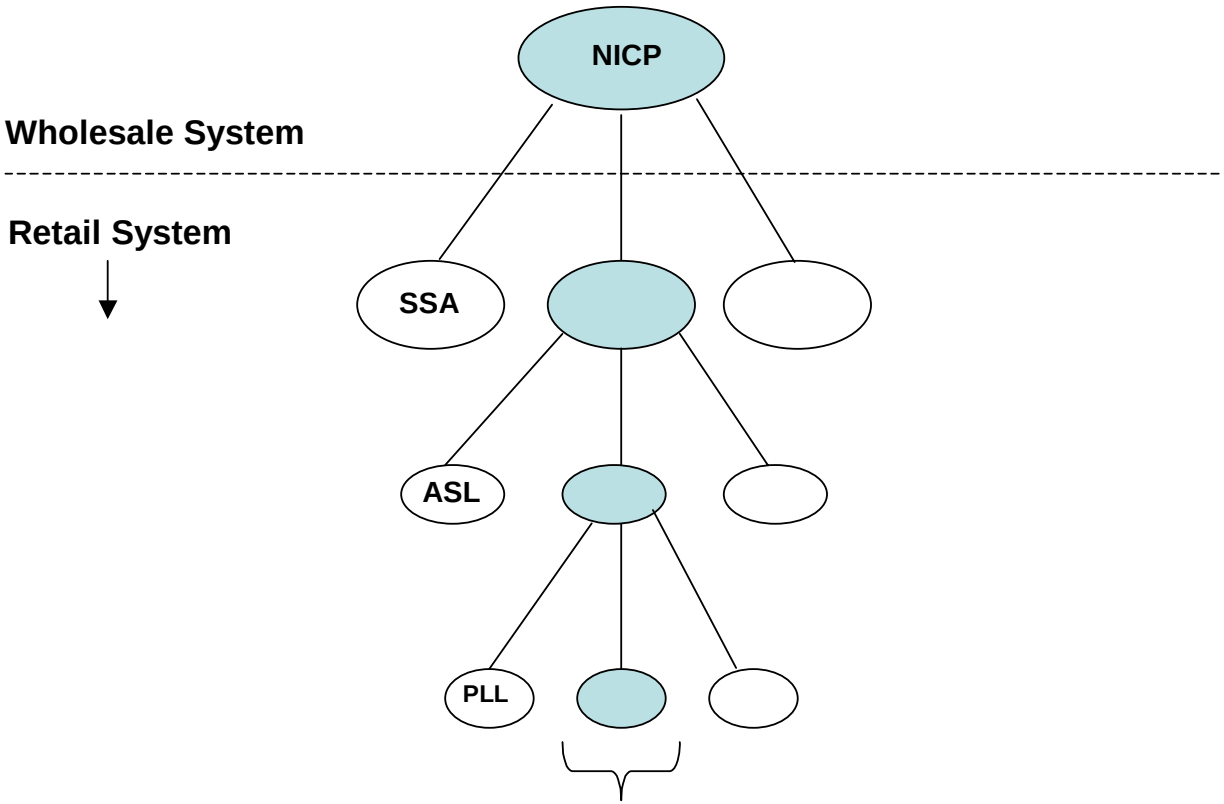
- AMSAA – “Optimizing Wholesale and Retail Investment Levels: Multi-Echelon, Multi-Indenture Optimization Models (Multi-Link)”

Impact of Increased Investment at Wholesale on Blackhawk Equipment Readiness at 101st Airborne



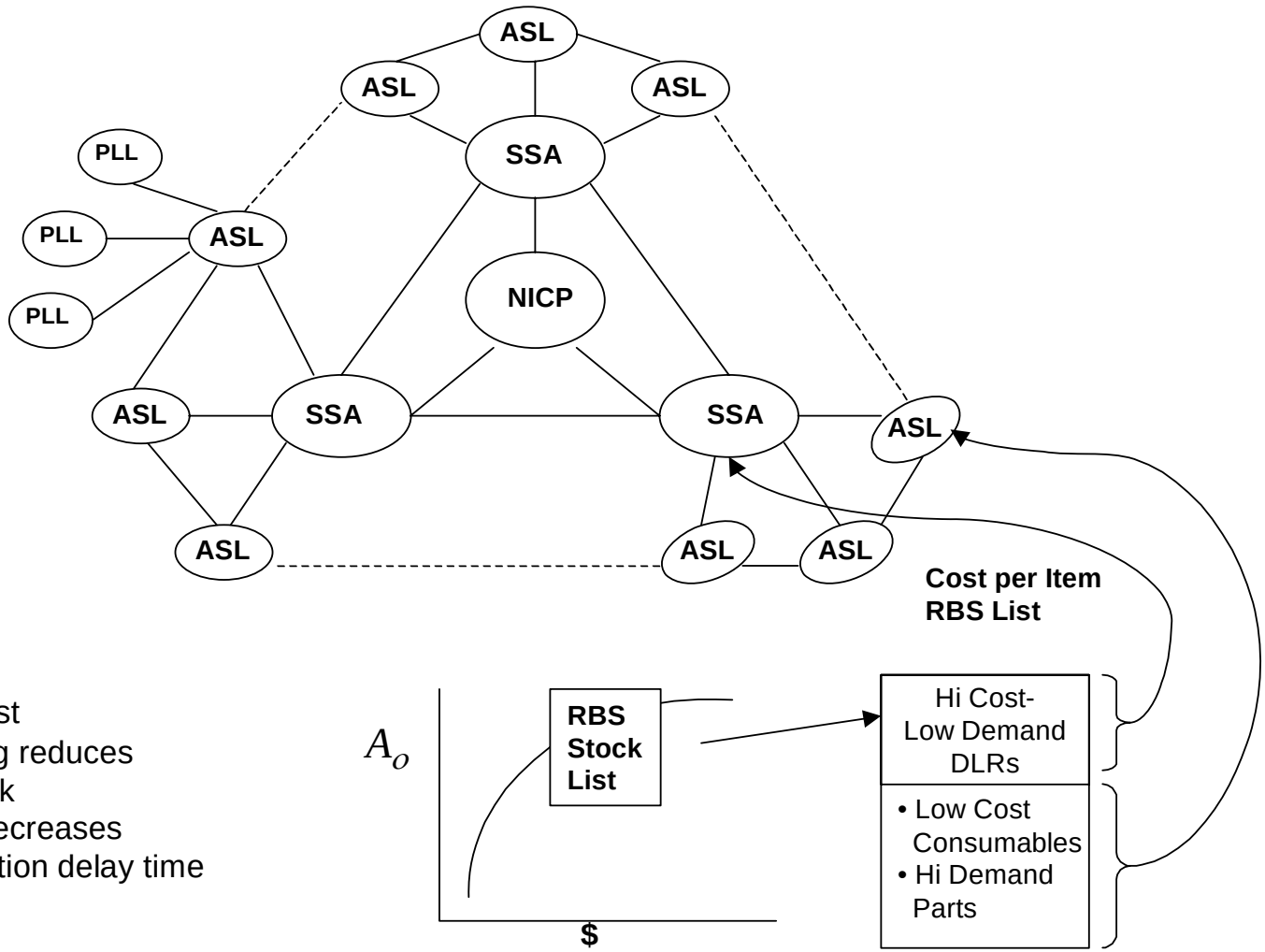
Source: AMSAA

Current Structure: Arborescence



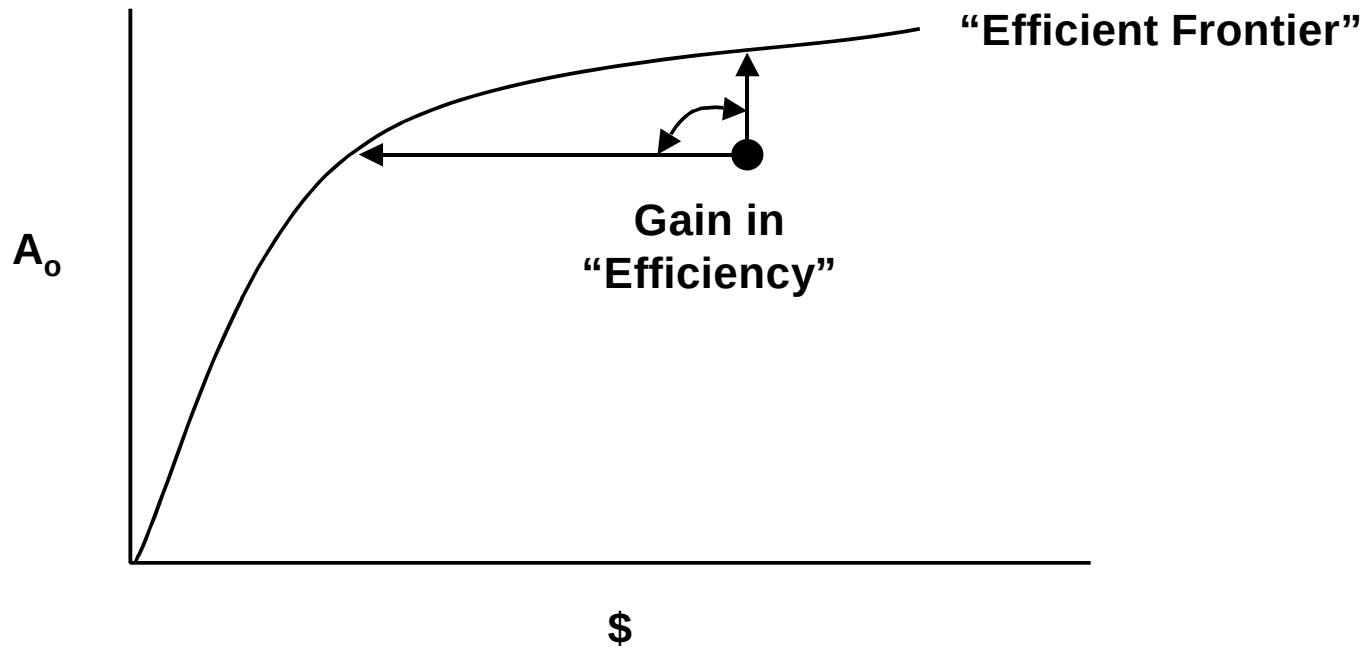
- Vertical “serial chains” create vulnerable supply channels
- Increased buffer stock is required to reduce risk
- Results in increased inventory investment costs

Demand Driven Supply Network (DDSN)

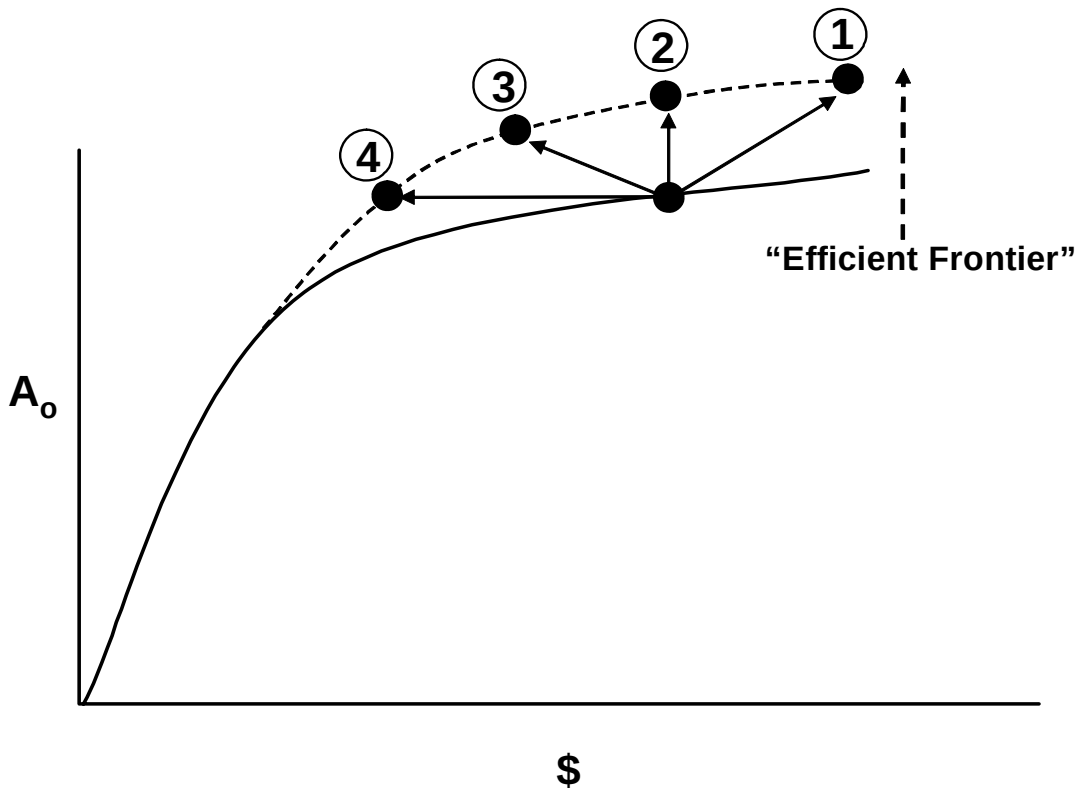


- RBS reduces cost
- Inventory pooling reduces both cost and risk
- Lateral supply decreases requisition delay time

Achieving “Efficiency” in the Cost - Availability Tradespace



Increasing “Effectiveness” in the Cost -Availability Tradespace

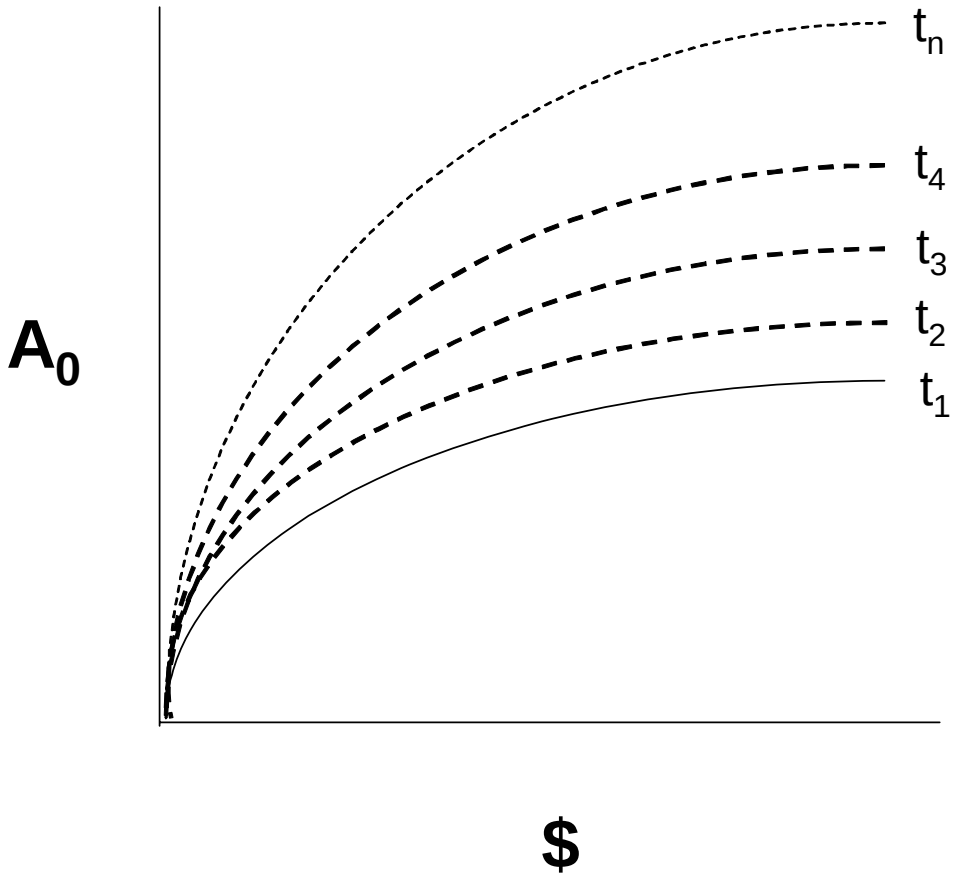


Cost Benefits Alternatives:

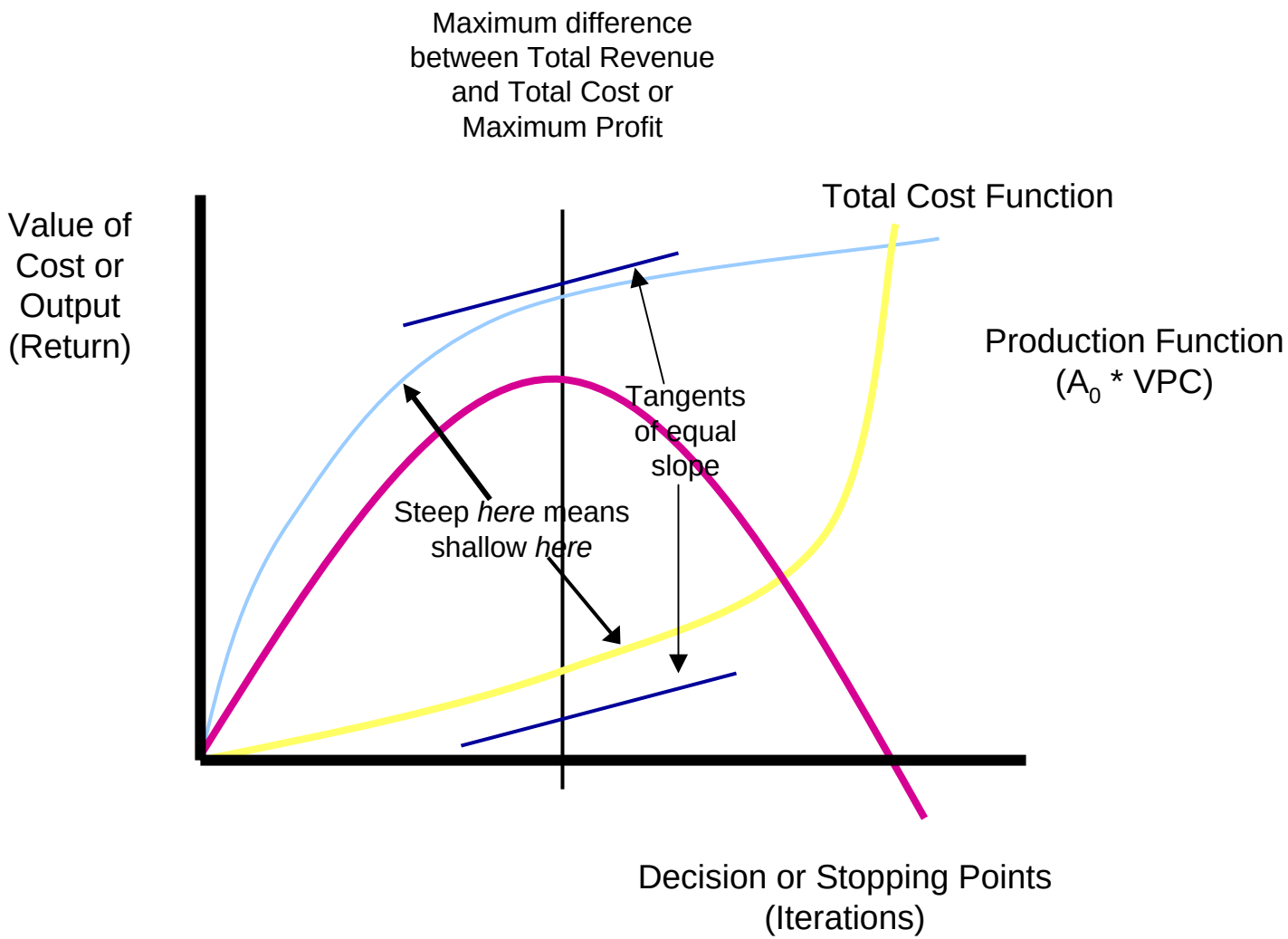
1. Improved effectiveness with increased costs
2. Improved effectiveness at same costs
3. Improved effectiveness at reduced costs
4. Same effectiveness at significantly reduced costs

… however, magnitude of each depends upon where you are on the current efficient frontier!
… and the expansion trace of the improved frontier

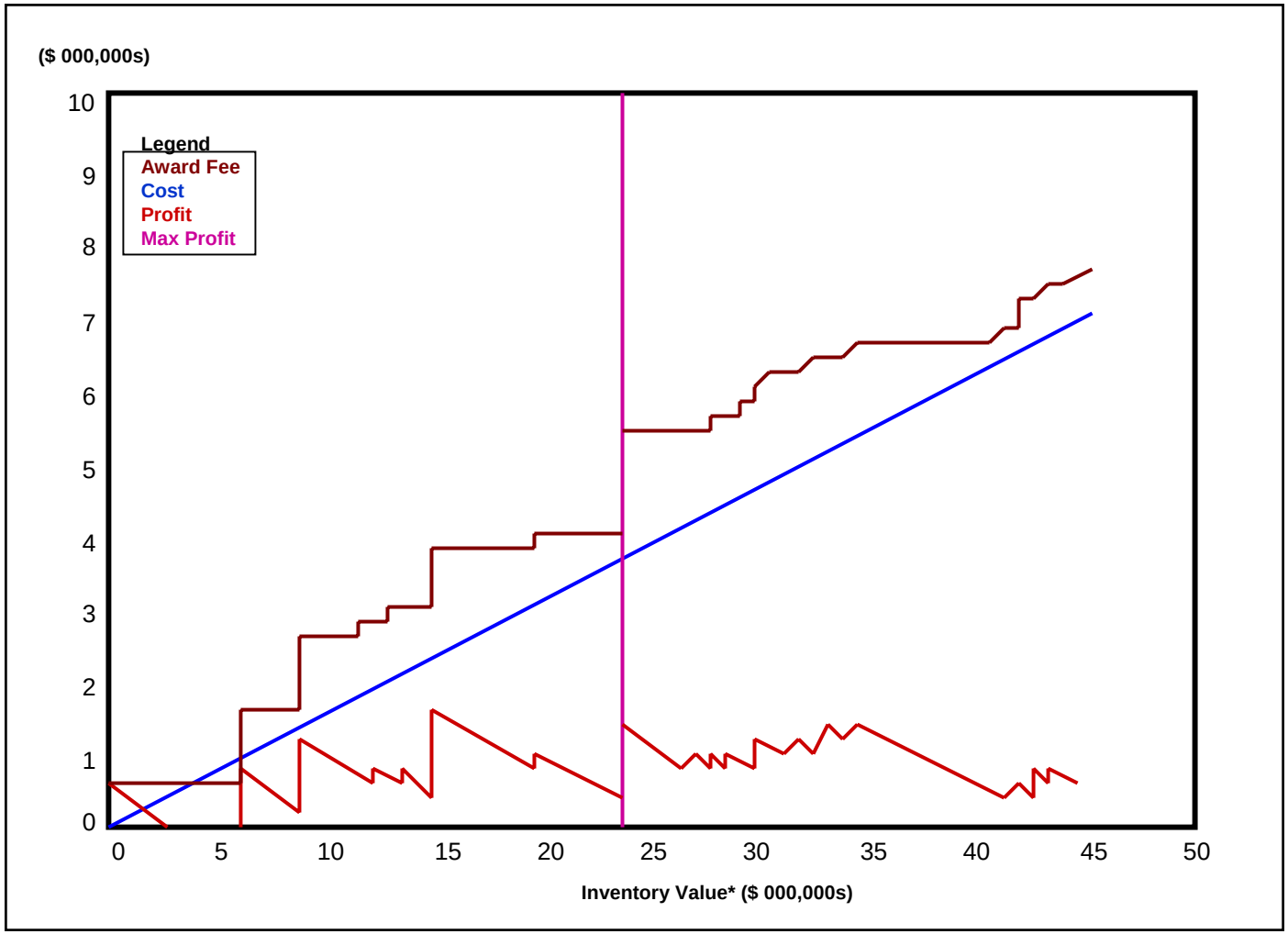
Pushing the Envelope: Innovation to Sustain Continual Improvement



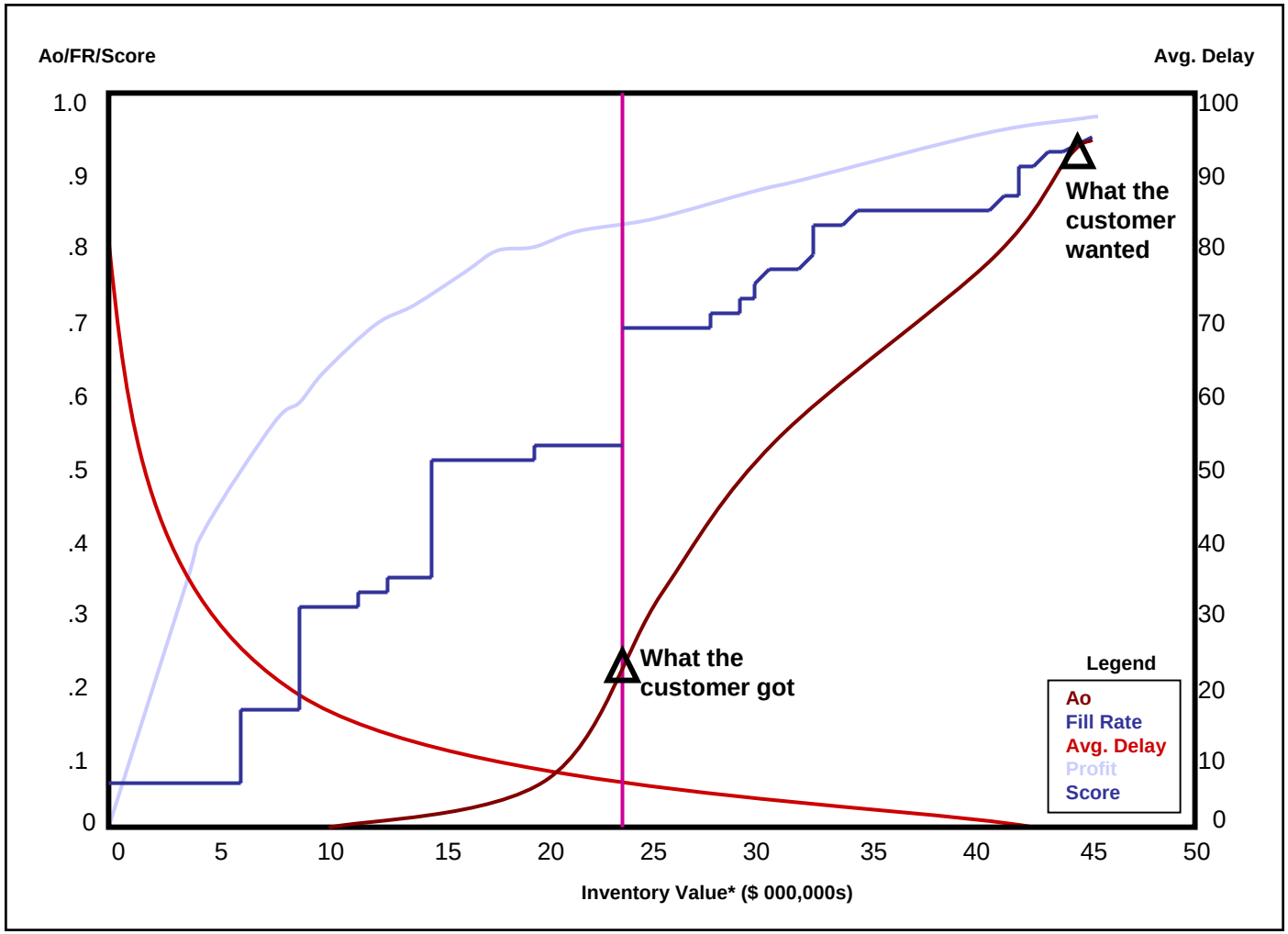
Total Cost Function



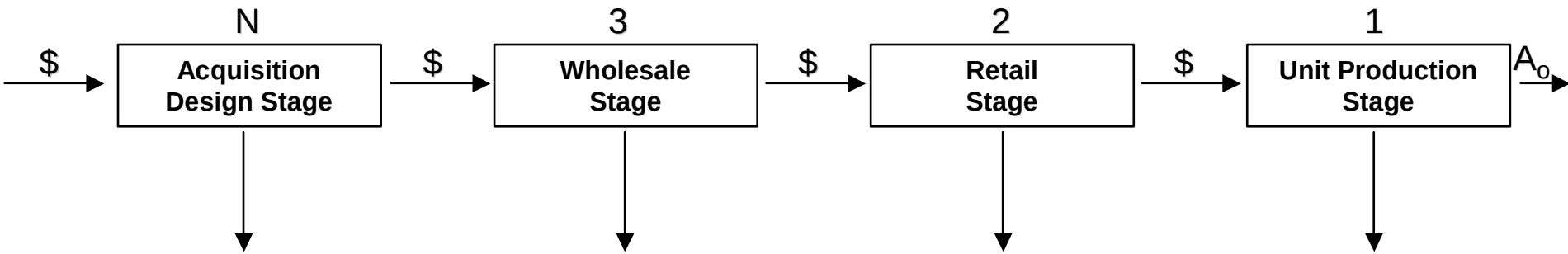
Profit

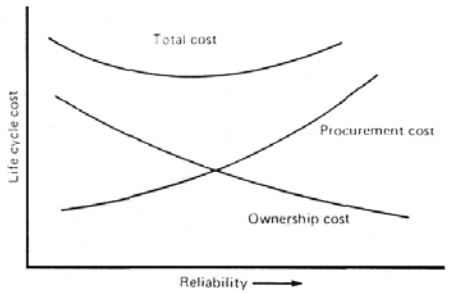

($ 000,000s)
10
9
8
7
6
5
4
3
2
1
0
Legend
Award Fee
Cost
Profit
Max Profit
0
5
10
15
20
25
30
35
40
45
50
Inventory Value* ($ 000,000s)

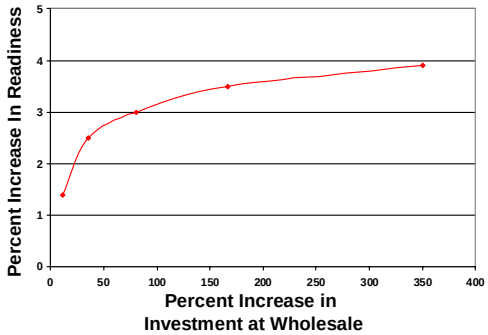
An Important Disconnect

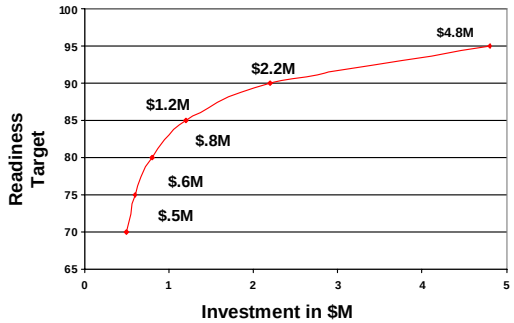


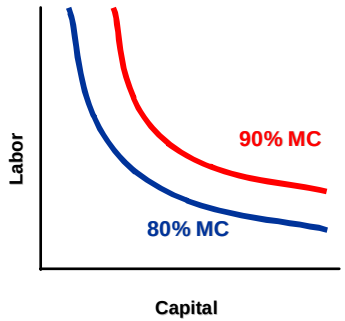
"Optimizing" the System: Applying a Dynamic (Multi-Stage) Programming Model











10.4 DEVELOPING AN OPTIMAL DECISION POLICY

If our multistage system actually looks like the one just illustrated, then we can notice some interesting characteristics; namely,

1. There are exactly N points at which a decision must be made.
2. If we *start* at stage 1, then nothing affects an optimal decision except the knowledge of the *state* of the system at stage 1 and the choice of our *decision variable*.
3. Stage 2 only affects the decision at stage 1; the choice we make at stage 2 is governed only by the *state* of the system at stage 2 and the restrictions on our decision variable.
4. And so on to stage N.

The dynamic programming problem is therefore given by the following expression at the nth stage:

$$f_n^*(S_n) = \max_{0 \le d_n \le \lfloor S_n/L_n \rfloor} \{r_n(S_n, d_n) + f_{n-1}^*(S_{n-1})\}$$

where: $S_{n-1} = S_n - d_n L_n$

and $f_0^*(S_0) \equiv 0$

$f_n(S_n, d_n) = r_n d_n$

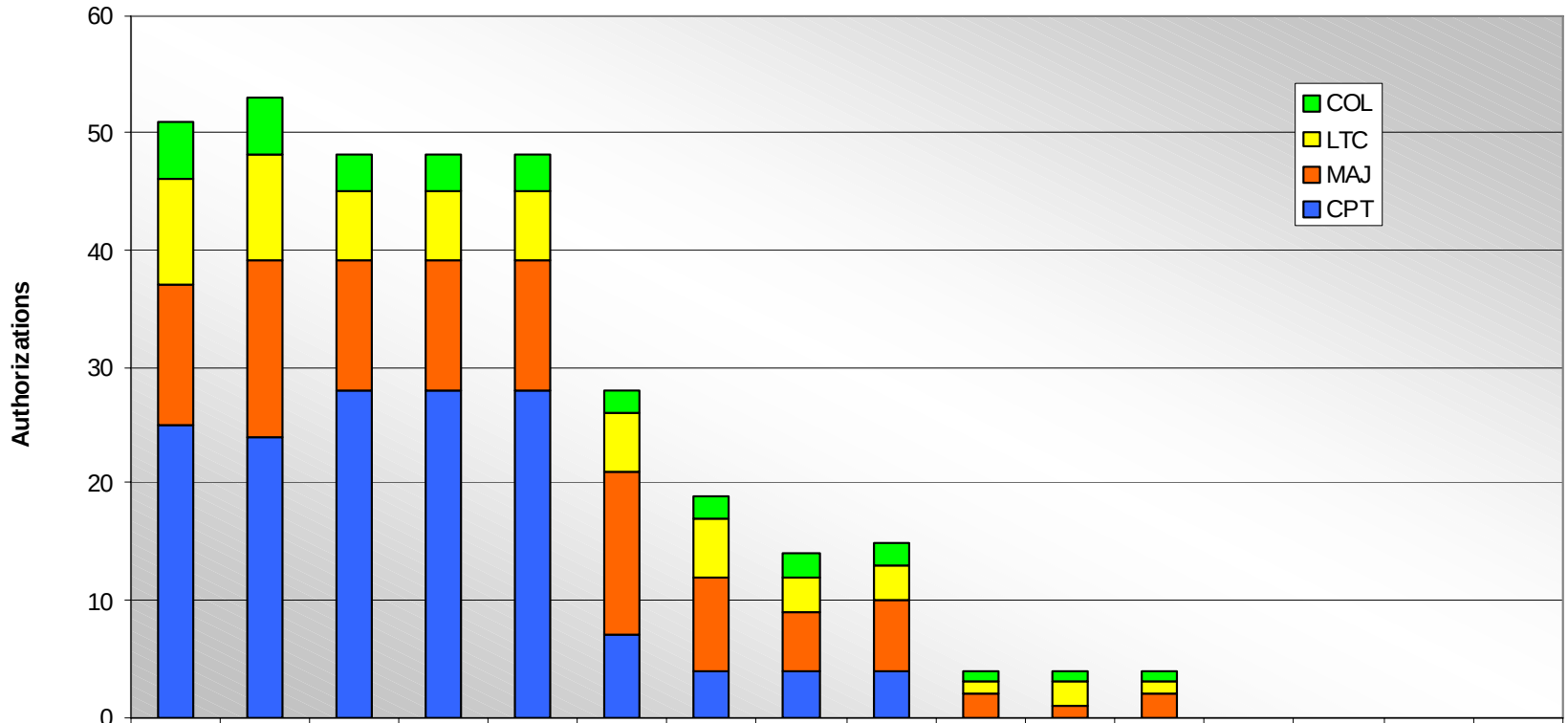
$n = 1, 2, 3, 4$

V. Strategic Management Concepts

1. Organizational Redesign
2. Contributions of (Transactional) Information Systems Technology and (Analytical) Operations Research
3. Strategic Management Concepts and the Learning Organization
4. Logistics Transformation and Disruptive Change

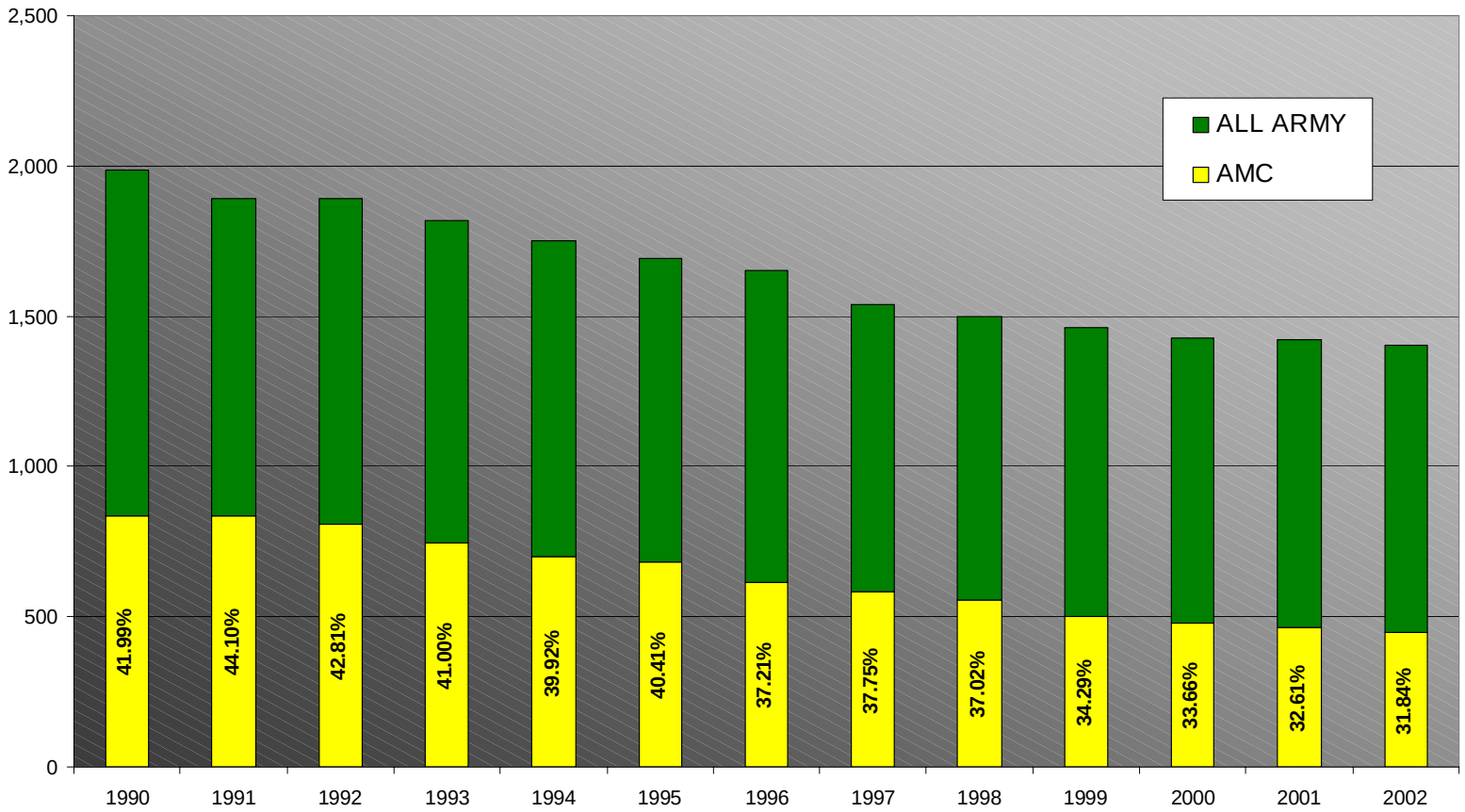
Logistics Transformation Framework: Linking Strategy to Measurable Results

Officer ORSA (FA49) Strength in AMC

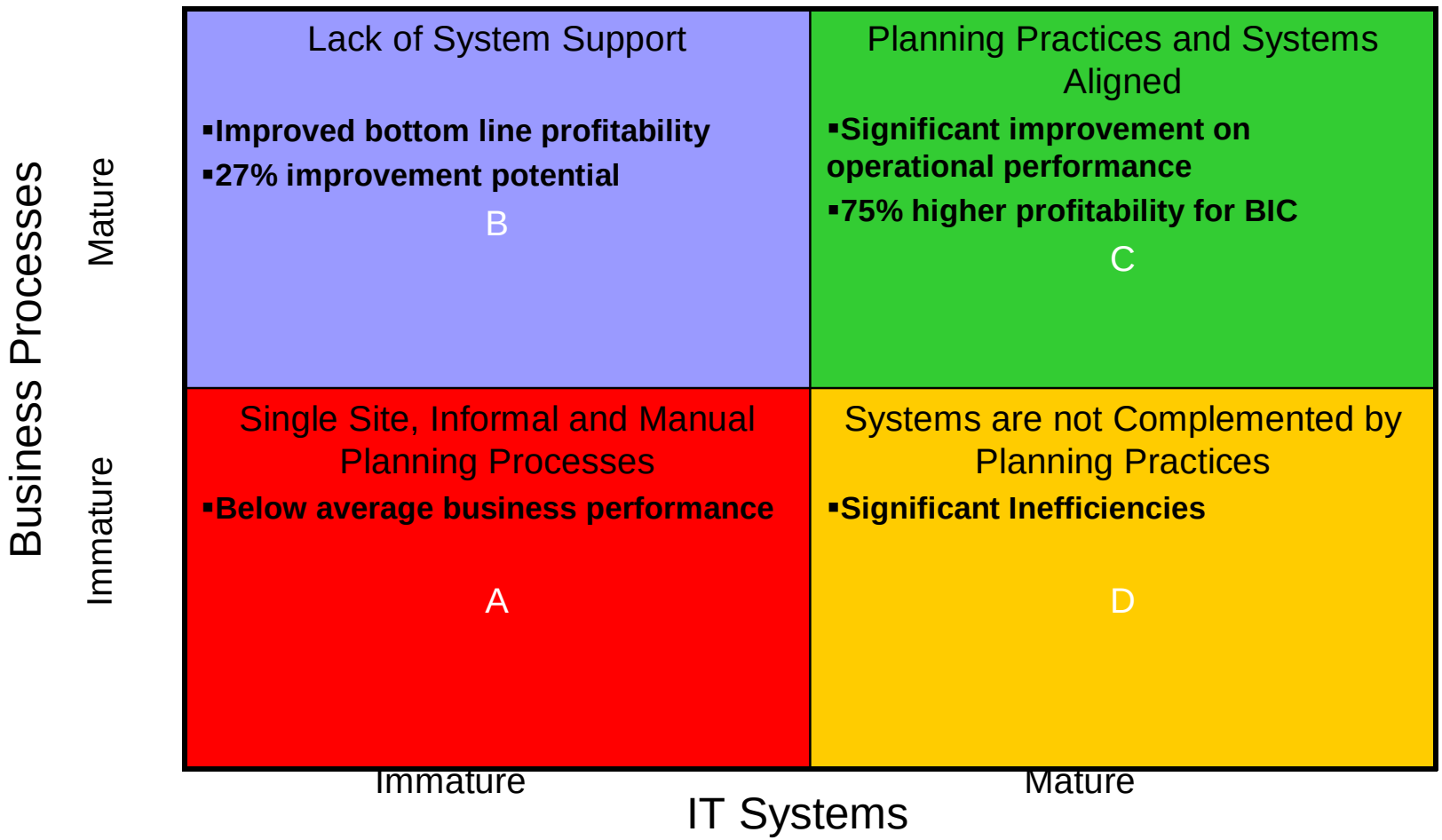


	FY88	FY89	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03
COL	5	5	3	3	3	2	2	2	2	1	1	1	0	0	0	0
LTC	9	9	6	6	6	5	5	3	3	1	2	1	0	0	0	0
MAJ	12	15	11	11	11	14	8	5	6	2	1	2	0	0	0	0
CPT	25	24	28	28	28	7	4	4	4	0	0	0	0	0	0	0

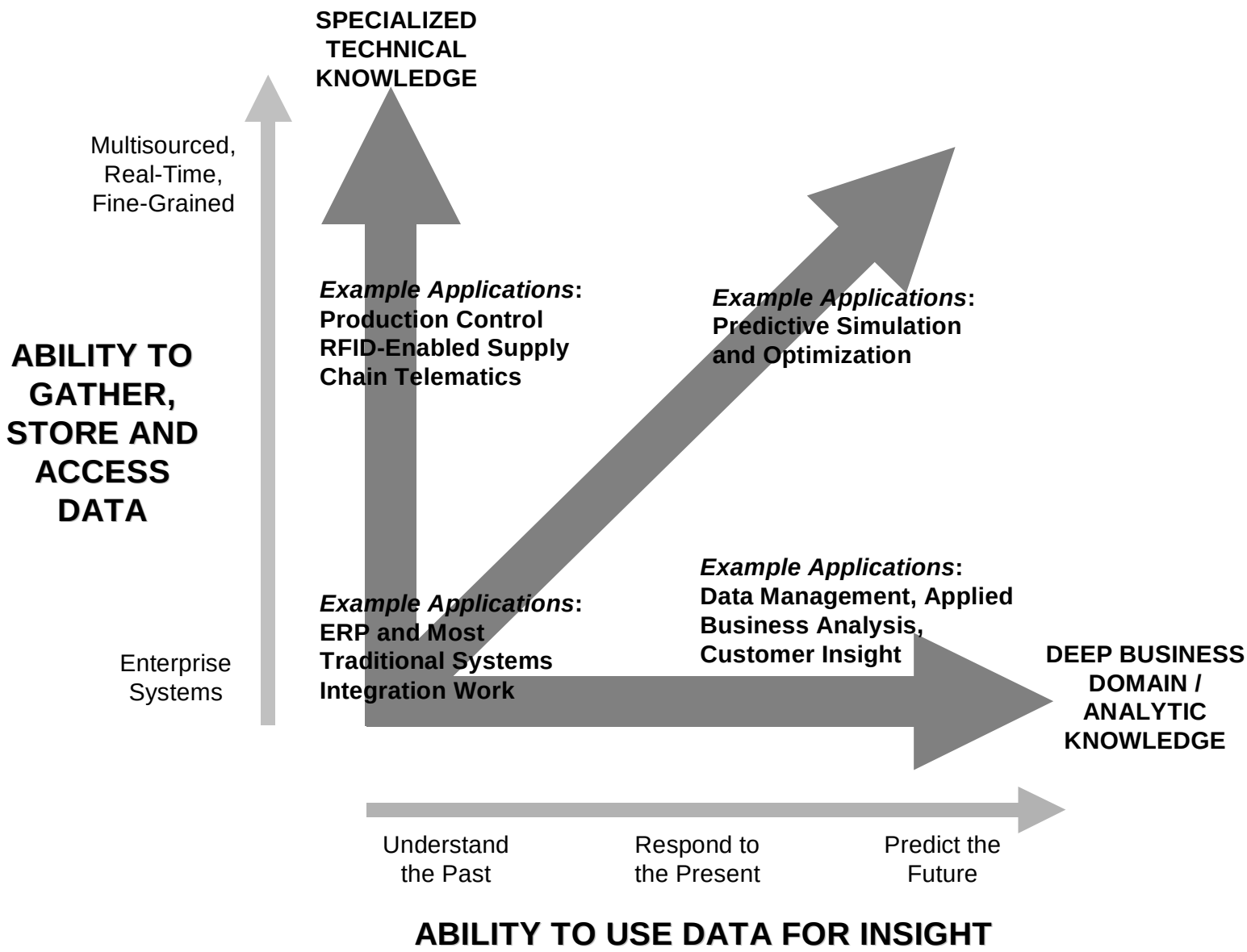
Civilian “ORSA” (1515) Strength in AMC



Linking processes and systems with operational and financial performance



The Evolution of Insight



Objective Hierarchy:

Relating Outcomes (Results) to Goals & Objectives (Strategy)

Goal: **Improve Logistics Chain Efficiency and Effectiveness to Enable a Strategically Responsive, Transforming Army**

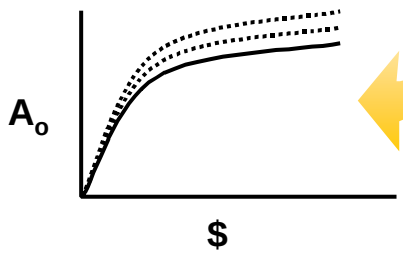
Objectives:

- Reduce Lead Time Demand & System Variability
- Improve Strategic Mobility; Reduce Force Closure Timelines
- Reduce Sustainment 'Footprint'
- Reduce Costs While Maintaining Readiness

Performance Measures: (MOEs, 'Metrics')

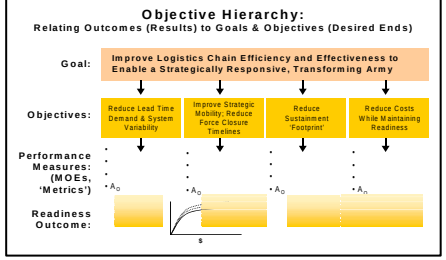
- A_O
- A_O
- A_O
- A_O

Readiness Outcome:



Aligning Execution and Strategy: Learning from Performance Variability

Select Performance Indicators



Detect Variability

- Drill down to detailed segmentation
- Isolate variability

Explain Variability

- Identify performance drivers
- Correlate drivers with variability

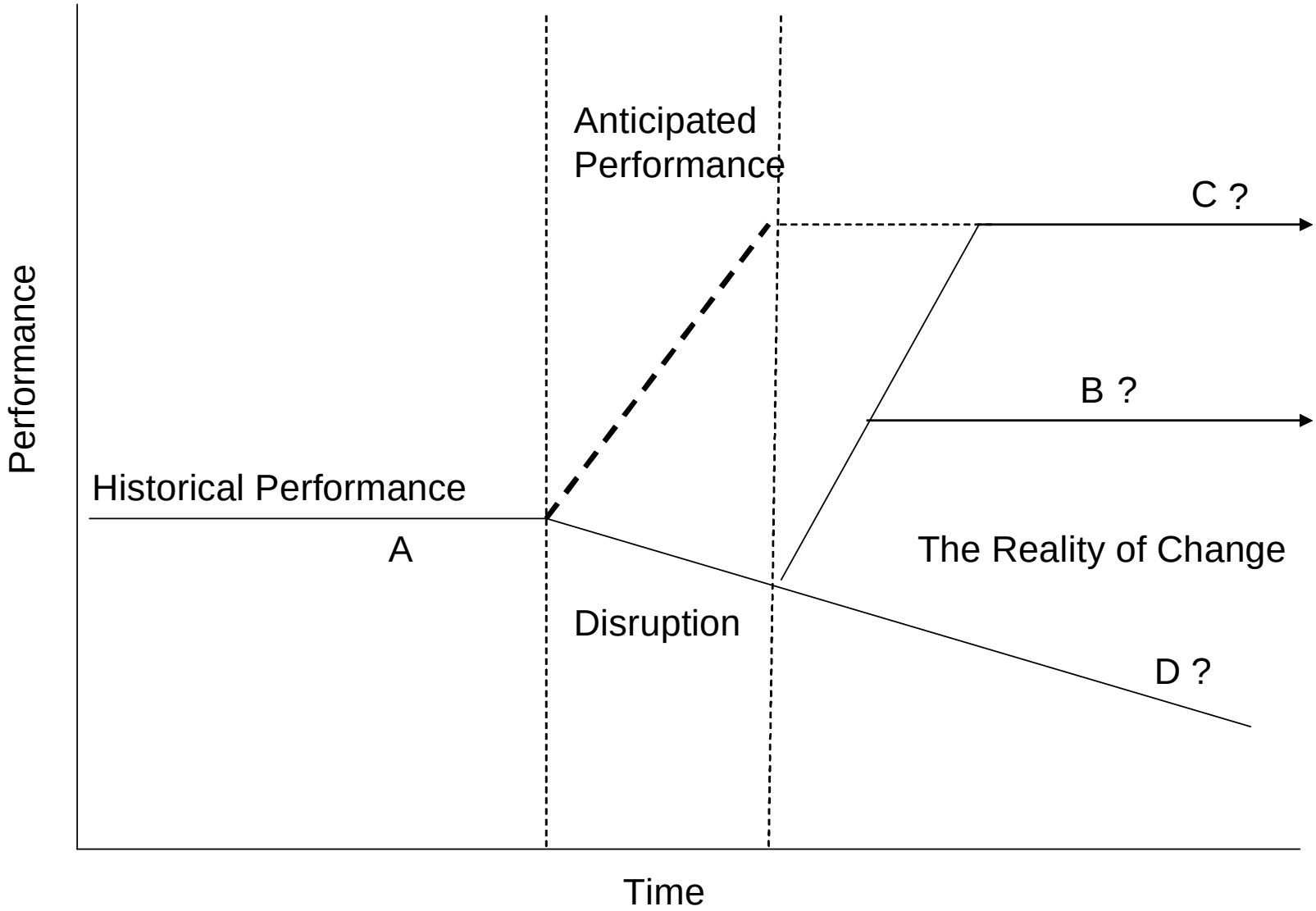
Learn from Variability

- Hypothesize cause and effect
- Evaluate

Act from Variability

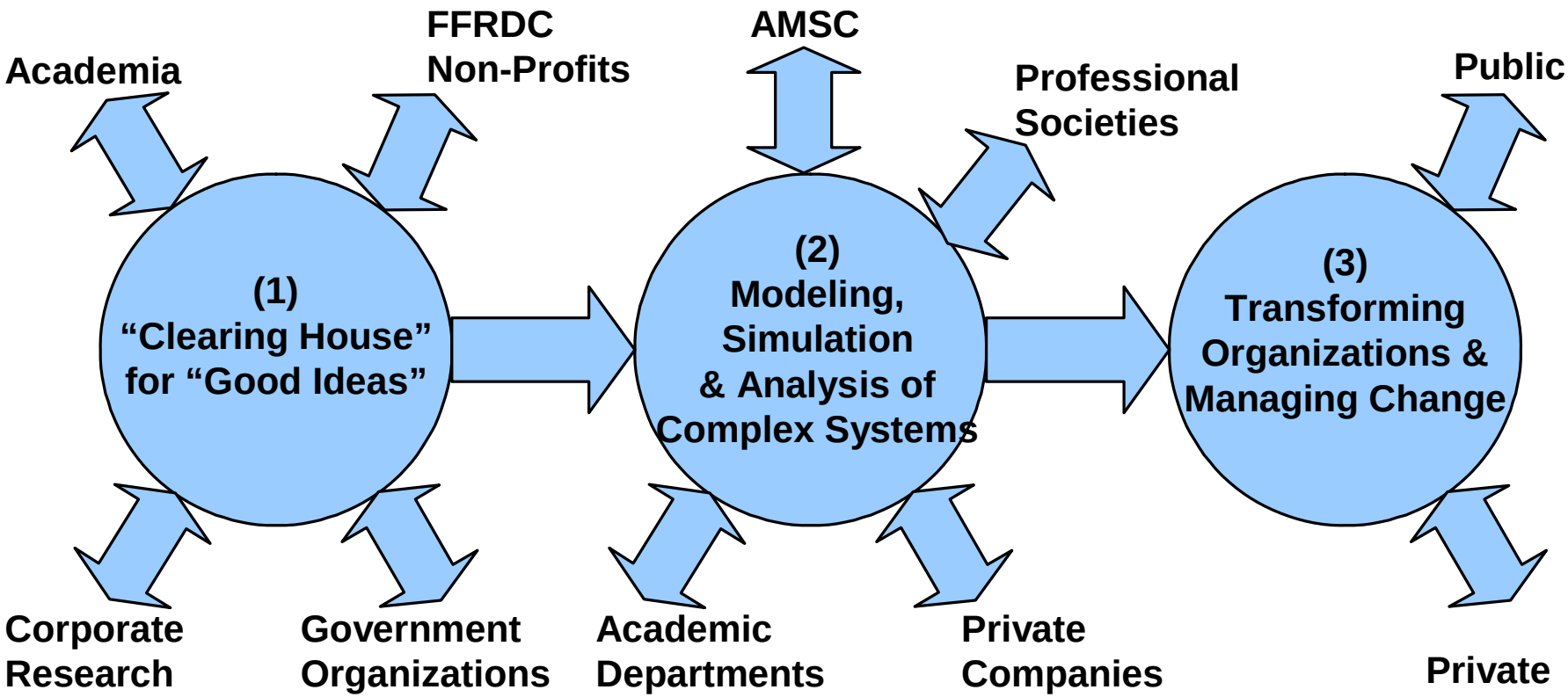
- Define program
- Define structured tests
- Implement

Common Expectations and the Reality of Change



VI. Summary
VII. Final Thoughts

“Center for Innovation in Logistics Systems”

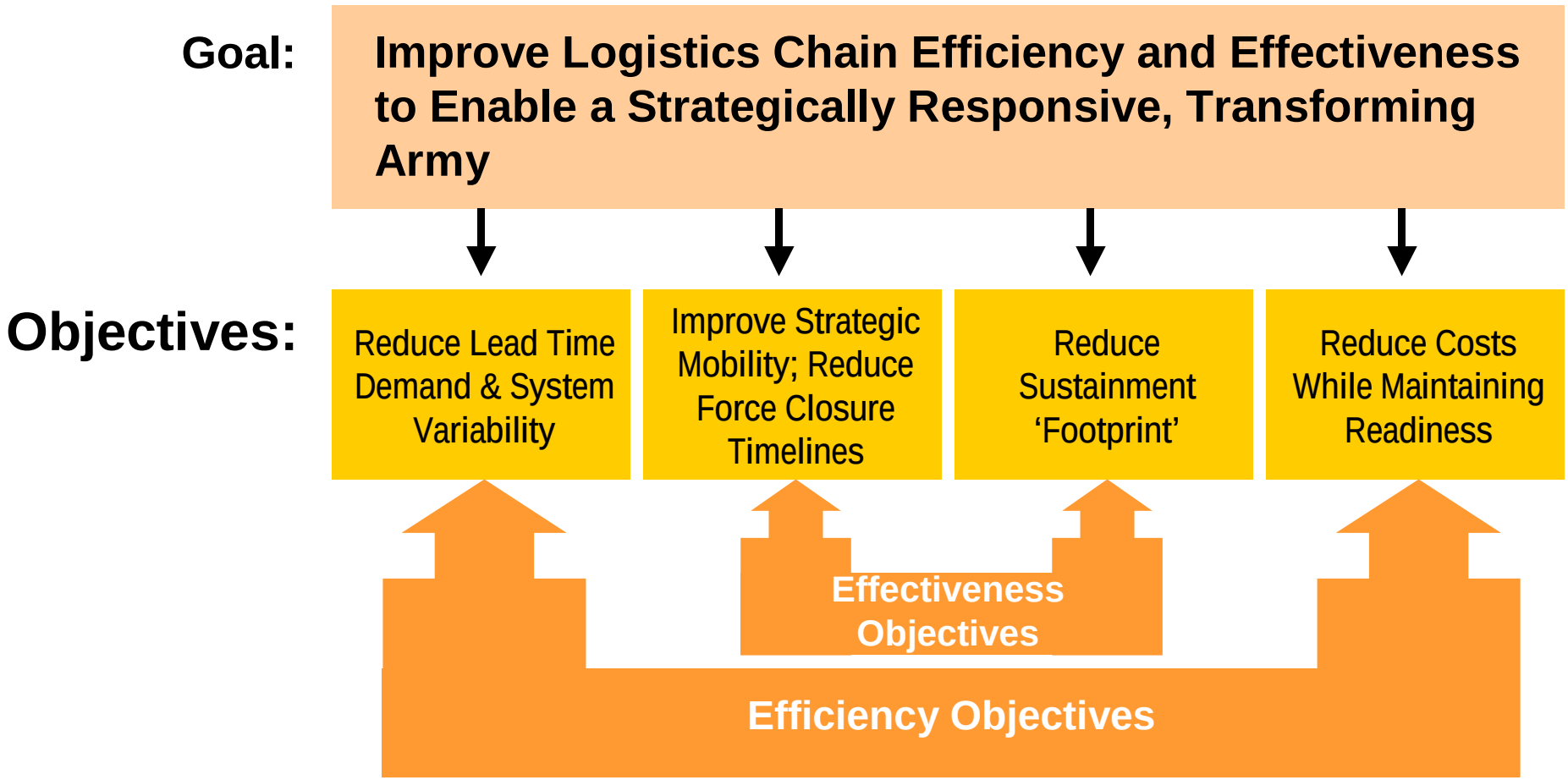


- Organizational Design
- Supply/Value Chain
- Workforce Development
- Technology Implications
- Innovation & Productivity Gain

- System Dynamics Modeling
- Large Scale (LS) System Design, Analysis, and Evaluation
- Systems Simulation, Modeling and Analysis

- Education & Training
- Technical Support
- Risk Reduction & Mitigation
- Consulting
- Research, Studies, and Analysis

Objective Hierarchy:
Purpose of Objectives



Objective Hierarchy:
Sources and Basis for Objectives

Goal: **Improve Logistics Chain Efficiency and Effectiveness to Enable a Strategically Responsive, Transforming Army**

Objectives:

- Reduce Lead Time Demand & System Variability
- Improve Strategic Mobility; Reduce Force Closure Timelines
- Reduce Sustainment 'Footprint'
- Reduce Costs While Maintaining Readiness

- **Classical Inventory Theory**
- **Recent Developments in Supply Chain Management Theory**
- **"Benchmarking" Against Corporate Sector Best Business Practices**

- **Army Transformation Campaign Plan**
- **Army Transformation Roadmap**
- **Army Modernization Plan, 2003**
- **G4/LTA "Army Logistics Transformation", Jan 03**

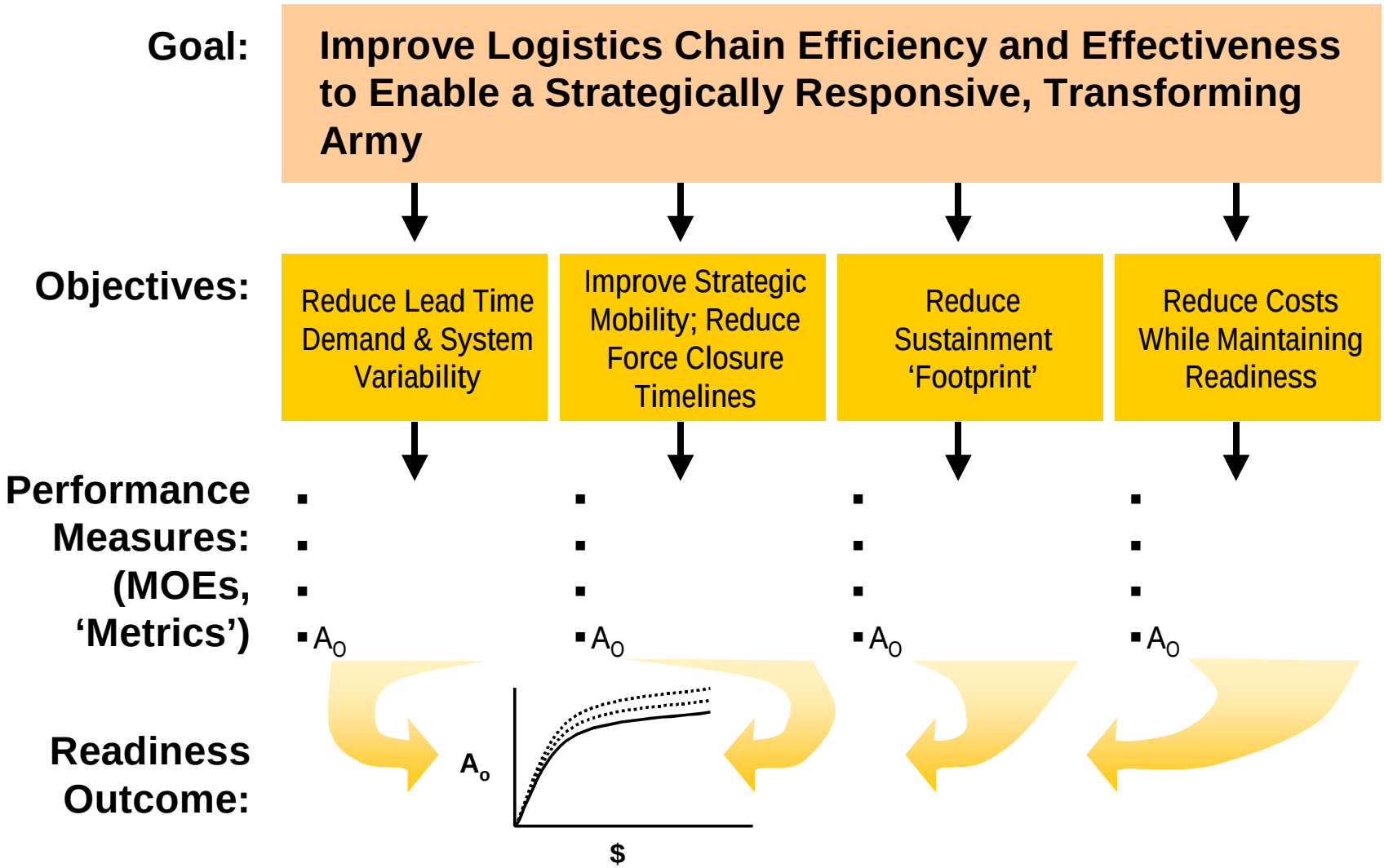
Objective Hierarchy:
Performance Measures

Goal: **Improve Logistics Chain Efficiency and Effectiveness to Enable a Strategically Responsive, Transforming Army**

Objectives:	Reduce Lead Time Demand & System Variability	Improve Strategic Mobility; Reduce Force Closure Timelines	Reduce Sustainment 'Footprint'	Reduce Costs While Maintaining Readiness
Performance Measures: (MOEs, 'Metrics')	▪ σ_L ▪ σ_D ▪ $Var(q^k)/Var(D)$ ▪ L x D ▪ A_O	▪ Lift Requirements ▪ Time to Deploy ▪ ▪ ▪ A_O	▪ Weight ▪ Cube/Volume ▪ System MTBF ▪ CSS Structure ▪ A_O	▪ Total Rqmts Objective ▪ Safety Stock ▪ Service Levels ▪ RL Delay Time ▪ A_O

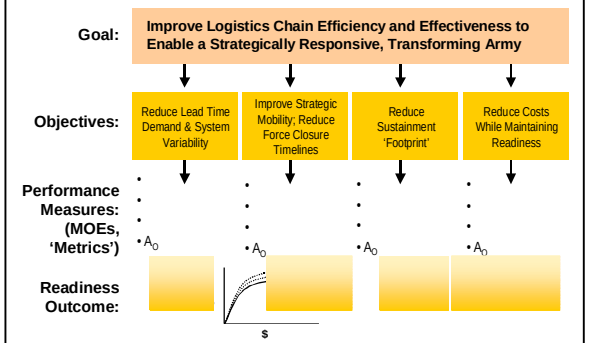
Objective Hierarchy:

Relating Outcomes (Results) to Goals & Objectives (Desired Ends)

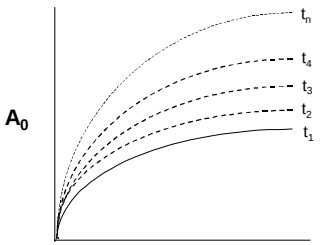


Sustaining Innovation While Linking Execution to Strategy

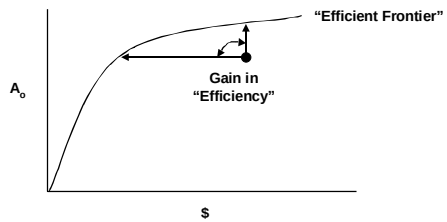
Objective Hierarchy:
Relating Outcomes (Results) to Goals & Objectives (Desired Ends)



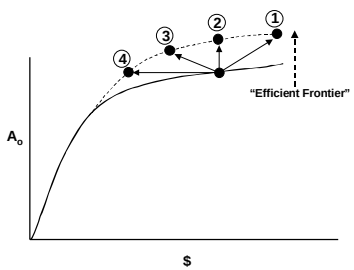
Innovation to Sustain Continual Improvement



Achieving "Efficiency" in the Cost - Availability Tradespace



Achieving "Effectiveness" in the Cost -Availability Tradespace



Cost Benefits Alternatives:

1. Improved effectiveness with increased costs
2. Improved effectiveness at same costs
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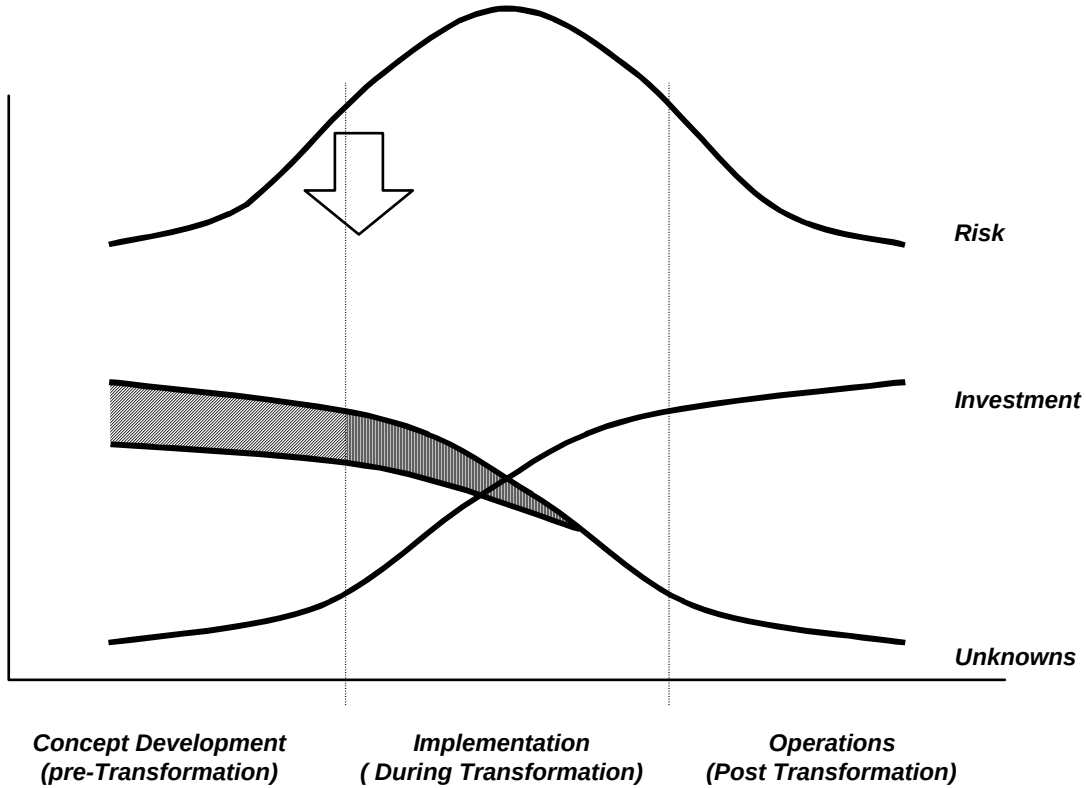
4. Same effectiveness at significantly reduced costs

… however, magnitude of each depends upon where you are on the current efficient frontier!
… and the expansion trace of the improved frontier
(i.e., "Pushing the Envelope")

Reducing Organizational Risk: Analytical Demos, Field Tests & Experimentation

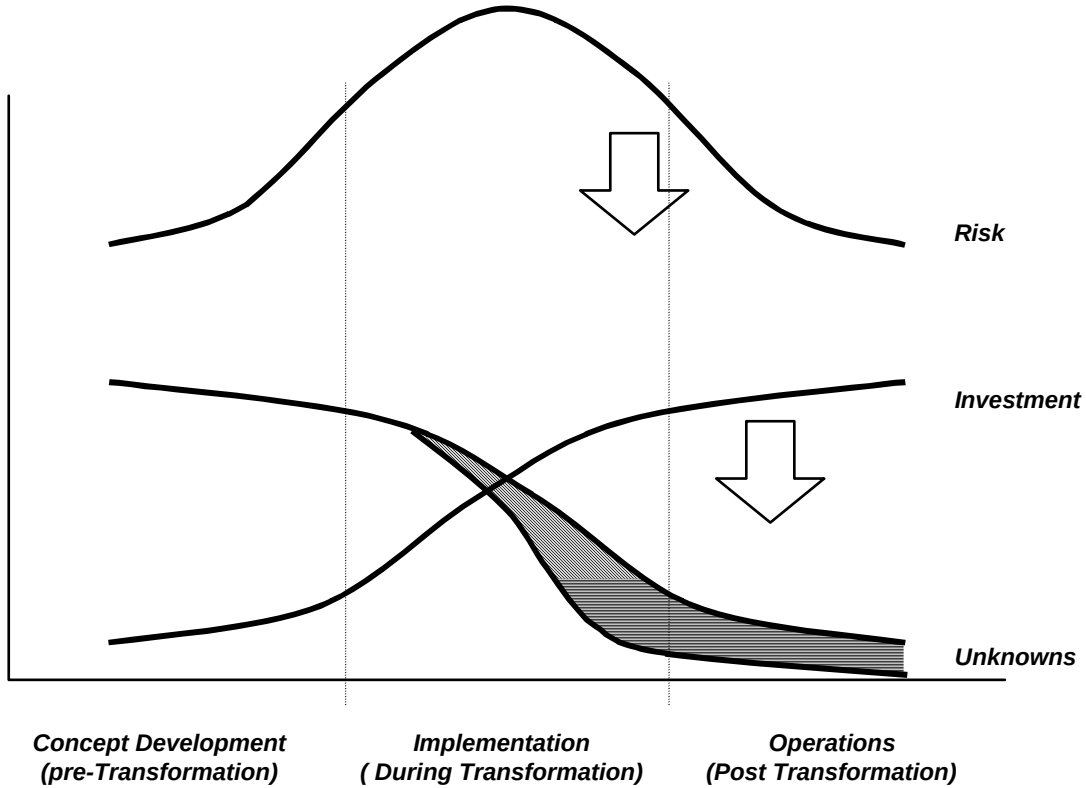
- Analytical "Demonstrations"
  - Modeling, Simulation, & Analysis
  - Assess Empirical Data
- Field Testing
  - Experimentation
  - Testing and Evaluation
  - Analysis
  - Prototype Fieldings



Reducing Organizational Risk: Systems Analysis, Management Information (MIS) & Decision Support (DSS)

- Regression Analysis
  - "Disentangling" Cause & Effect
  - Empirically–based results

- Econometric Forecasting
  - Can forecast with increasingly greater accuracy and precision
  - Quantifies relationships between current/recent investment decisions and future outcomes
  - Precludes "surprises" in tightly-coupled systems



Reduced “Transformation” Risk: Using Analysis to Disentangle Cause & Effect, Reduce Uncertainty, and Mitigate Risk